CONTRIBUTION TO THE STUDY OF ANCIENT HINDU MUSIC.

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THE subject of ancient Hindu music does not seem to have received that attention from Indianists which it deserves. More than a century ago Sir William Jones, Francis Fowke, J. D. Paterson, etc., made attempts to elucidate Hindu music. But those were days of pioneering work, when very little was known of Sanskrit literature to European scholars, and the *Siddhânta-Kaumudi* was considered to be the title of the grammatical work of Pâṇini and Kallinâtha passed for a *rishi*. Since that time no attempt has been made to interpret Sanskrit treatises on music. Thus, Râjâ S. M. Tagore, who has done so much to attract attention to Hindu music, and has compiled a small Sanskrit book on the subject, almost invariably follows the authors just mentioned; and Captain Day, who has rendered such a great service to the present day Karnatik system of music, has simply contented himself by quoting from the writings of the Râjâ and the previous writers, when treating of the theory and old practice of Hindu music. The only exception is that of Monsieur J. Grosset, who has not only gone back to original Sanskrit authors, but has been the first, as far as my knowledge goes, to study the most ancient of them, *viz.*, Bharata. Unfortunately besides the various disadvantages under which a foreign scholar, living outside of India, naturally labours in a work of this sort, Monsieur Grosset manifests too much faith in the writings of Râjâ S. M. Tagore. The necessary result of this has been the propagation of errors originally made by the pioneers named above. Thus one finds them in Carl Engel's writings, Ambros' *Geschichte der Musik* and Helmholtz's *Sensations of Tone*, to mention only the most important works. It is hoped that the following essay will help to correct these errors.

There are other serious defects also in the writings of Sir W. Jones and his contemporaries. Thus, the authors have no first-hand knowledge of some of the Sanskrit works on music they mention. For instance, Sir W. Jones attributes various things to Bharata, which do not occur in that author's work. Indeed, *Saṃgîta-Nârâyaṇa* and Somanâtha's *Râga-vibodha* seem to be the only treatises of which he has a direct knowledge, and even then he has not discovered the date of the composition of the latter, though it is given at the end of that book, and simply remarks that "it seems a very ancient composition." This tendency of referring everything Hindu to the hoary past is a characteristic fault of writers of this period, and is, of course, quite excusable, considering the limited knowledge of Indian matters at the time. It is regrettable, however, to find it in later writers, as for example, when Râjâ S. M. Tagore, a century later, refers Hindu musical notation to "an age anterior to the commencement of the authentic history," and produces in support of his statement nothing older than the facsimile of an air from Somanâtha's work (A.D. 1609), which had originally appeared with Sir W. Jones' paper.

In the following essay, pains have been taken to indicate the probable period of a particular stage of Hindu music under discussion, which, it is hoped, will incidentally show the unsafeness of the common argument of "the well-known hatred of change of the Hindus," so often called into requisition when definite knowledge fails.

I have taken the following Sanskrit treatises on music to serve as sign-posts in the development of that art:—

1. *Bhâratîya-nâṭya-śâstra, circa* 4th century A. D. Abbrev. Bh. (Kâvyamâlâ edition).
2. Śârṅgadeva's *Saṃgîta-ratnâkara*, written some time between A.D. 1210-1247. Abbrev. S. R. (Anandashrama edition).
3. Somanâtha's *Râga-vibodha*, A. D. 1609. Abbrev. R. V. (ed. Gharpure).
4. Ahobala's *Saṃgîta-pârijâta, circa* the latter half of the 17th century. Abbrev. S. P. Poona edition, unless Calcutta edition be specially mentioned).

This choice has been determined by the fact that all these works have been printed and are thus easily available.

1. *Bhâratîya-nâṭya-śâstra.*—This is the oldest Sanskrit work which treats of music, among other subjects. It is useless to try to determine the date of the author, even if it were possible to do so, because the present text is evidently the result of many re-handlings even in comparatively recent times. Thus, certain verses quoted from Mâtṛigupta's work and the *Nâṭyalochana*, by Râghavabhaṭṭa in his commentary on the *Śâkuntala*, are found in the present-day text of Bharata. Again, probably there came into existence various recensions of the work, as for example, the *Nandi-bharata*[1], or Bharata according to Nandin. Nay, it would further appear that the term *bharata* came to mean "dramaturgy" generally, as shown by the title *Mataṅga-bharatam*, a work by Lakshmaṇa-Bhâskara, for though this work is not yet discovered, in no other sense can the writings of Mataṅga be called '*bharatam.*' In contra-distinction to these later *bharatas*, as it were, Râghavabhaṭṭa mentions a work called *Âdibharata*. A manuscript with this name exists in the Mysore Oriental Library, but a cursory examination of the chapter on music corresponding to the 29th in the published edition does not show any more marked difference than is found in other manuscripts, bearing the ordinary name.

It will thus be evident that the facts that Bhavabhûti refers to Bharata as *taurya-trika-sûtra-kâra* (composer of the rules of the three arts of dancing, singing and instrumental music), and that Kâlidâsa also mentions him as a *muni* (ancient sage), simply show that a certain work by Bharata was known to those poets. What portions, if any, of the present text formed a part of the original, it is impossible to say. Nor is the argument derived from the mention of the *Prahravas* (Pehlavi) in a book of such a composite nature of any value in determining the date of the author, for, taking an extreme view, the fact can legitimately be said to throw light only on the date of the composition of the particular verse in which the word occurs.

It becomes necessary, therefore, to try to ascertain, if possible, the probable date of the composition of the various chapters, and sometimes even of the particular verses. At present we are concerned with the chapters treating of music. Even a cursory reading of these, as given in different manuscripts,[2] shows the enormous re-handling which the text has undergone. Thus a passage written in prose in one manuscript is found versified in another, and certain passages referring to the same matter read so differently in different manuscripts, that they must be looked upon, not merely as various readings, but as different compositions, though very often the meaning of the passages is the same. At times, however, a later interpolation is seen to be in disagreement with other parts of the work.

Under these circumstances an effort was made to find out whether there were any references to music in Kâlidâsa's works, which, by their discrepancy with the alleged work of Bharata, could suggest a priority of either. Unfortunately, I have not yet been able to find any such discrepancies, except the doubtful one contained in the 39th *śloka*[3] of the *Raghuvaṃśa*, canto I, where the *shaḍja* note of the gamut seems to be referred to as being of two varieties. The commentator Mallinâtha explains the two varieties as being either (*a*) *śuddha* and *vikṛita* or (*b*) *chyuta* and *achyuta*. If this explanation is to be accepted, it is evident that the stage of music represented by Bharata's work must be looked upon as earlier than that of Kâlidâsa's time, for, this distinction of the *shaḍja* note is not found there,—at least not under those terms,—and only occurs in later writers.

[1] See the end of the *Bhâratîya-nâṭya-śâstra*, Kâvyamâlâ series.

[2] I have consulted four MSS. (1) A of MM. Paul Ragnaud and J. Grosset, very kindly put at my disposal by the latter gentleman, (2) G. of the same authors, (3) P_1 and P_2 from the Deccan College Library, being copies of a Bikaner manuscript, (4) M. a manuscript from Mysore.

[3] षड्जसंवादिनीः केका द्विधा भिन्नाः शिखण्डिभिः

There is, however, no obligation to accept Mallinâtha's interpretation, as the two varieties of the note, *viz.*, (1) *shaḍja* and (2) *shaḍja-sâdhâraṇa*, mentioned in Bharata, are quite sufficient to explain the passage. Though the attempt to find out the priority of either of these works has thus failed, a comparison with the *Amarakośa* is apparently more successful. In Bharata occurs the word *kutapa* (a band of musicians), but it is not found in the *Amarakośa*, though one might expect it, if it were in existence, along with the terms for specific collections (*vṛindabheddḥ*) given in *ślokas* 41 and 42, *Kâṇḍa* II. 5, *e. g.*, *varga*, *saṅgha*, etc. The word *mârjanâ* occurs in Amara, but the technical meaning of it, as used in Bharata, *viz.*, 'a mode of tuning the triad of drums' is not given. But still more to the purpose is the occurrence of the word *kâkalî* in the *Amarakośa* among the musical terms, but without the specific signification of 'the note between the *nishâda* and the *shaḍja*,' which is assigned to it in Bharata and all later treatises on music. It would thus appear that probably the portion of the *Bhâratîya-nâṭya śâstra* under consideration is of a later date than the *Amarakośa*. Unfortunately, the date of this lexicon cannot be ascertained, and the opinions of scholars differ. Thus Weber assigns it to the 11th century A. D., whereas Prof. A. A. Macdonell, with more show of reason, says that it was 'not improbably composed about 500 A. D.' But one of the words given above, *viz.*, *mârjanâ*, occurs in Kâlidâsa in the technical sense, but not in the *Amarakośa*, and if there be any force in the argument used above, the lexicon must be looked upon as prior to Kâlidâsa. Perhaps a slightly added strength is given to this view by the occurrence of the word *mûrchhanâ* both in Kâlidâsa and Bharata, and its absence from Amara, though it may be urged that one has not got the same right to expect this word in that lexicon as the other word *mârjanâ*. According to the well-known tradition, Amara was the contemporary of Kâlidâsa, who lived about the end of the fourth century,[4] and this is the earliest date at present assigned to Amara. Even putting the date a century further back in compliance with this argument, the portion of the *Bhâratîya-nâṭya-śâstra*, which deals with music, cannot be assigned to an earlier period than the 4th century A. D.; and may indeed be of a later date. This of course does not mean that the music described in that work did not exist at an earlier period.

2. Śârṅgadeva's *Saṃgîta-ratnâkara*.—There is no difficulty now in fixing the date of this work. It must have been written between A. D. 1210 and A. D. 1247[5].

Śârṅgadeva mentions a large number of writers on *saṃgîta* (dancing, singing and instrumental music) between Bharata's and his own times, but their works are no longer extant, and one has to be content only with the few quotations found in the writings of the commentators on Śârṅgdeva's own work. This is very much to be regretted, because the period between Bharata and Śârṅgadeva was a very long one—seven or nine centuries—and music had undergone a very great evolution, which it is impossible for us to follow without the missing links. Śârṅgadeva's work itself, though extremely valuable otherwise, gives but little assistance in such a study, on account of the commonly accepted precept, that whenever there is a discrepancy between a *śâstra* (ancient rule) and a *lakshya* (actuality or actual practice), the former should be interpreted so as to tally with the latter (*vide* S. R., Adhy. vi. 331-341). It must be mentioned, however, that at times such discrepancies are noted by the author.

[4] R. G. Bhandarkar—*A Peep into the Early History of India*, p. 45.

[5] R. G. Bhandarkar—*Early History of the Dekkan* (2nd ed.), pp. 111-112. Here also occurs the following remark:—'There is a commentary on this work, attributed to a king of the name of Siṅga, who is represented as a paramount sovereign of the Andhra circle. This Siṅga appears in all likelihood to be Siṅghaṇa; and the commentary was either written by him or dedicated to him by a dependant, as is often the case.' The fact, however, that this commentary mentions another, *viz.*, that by Kallinâtha, *circa* A. D. 1459, goes against this conjecture. Further, it may be noted that in the portion of Siṁhabhûpâla's commentary published at Calcutta, there is no mention of the author being the paramount sovereign of the Andhra circle as in the manuscript referred to in the *Early History of the Dekkan*.

Of the many writers on music mentioned by Sârngadeva, Kohala was perhaps chronologically the next great author after Bharata, for, at the end of the Bh. we find the prediction that "Kohala will tell the rest" of the *nâṭya*.[6] Matanga seems to be comparatively a recent writer, and, to judge from the available quotations, appears to have rendered the same service to music in his own time as a compiler, which Sârngadeva himself did at a later period. Thus he is found to quote Bharata, Kohala, Kaśyapa and Durgâśakti[7] and reconcile different opinions.

3. Somanâtha's *Râgavibodha*.—The date of composition of this treatise is given at the end by the author himself as Saka 1531 *i.e.*, A. D. 1609.

4. Ahobala's *Saṃgîta-pârijâta*.—This work was translated into Persian in the year 1137 A. H. or A. D. 1724.[8] It will be seen hereafter, that this work represents a later stage in the development of music than the last treatise, and I have assigned it, therefore, to the latter half of the 17th century approximately.

Preliminary Remarks.

The following elementary considerations, though they ought to be well-known to students of the theory of music, do not seem to be recognised by many of the authors, who have written on the subject of Hindu music, and this is my excuse for introducing them here.

The modern European diatonic scale recognises two modes, the Major and the Minor:

The major mode	*c*	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2
The minor mode	*c*	*d*	*e♭*	*f*	*g*	*a*	*b*	*c'*
	1	$\frac{9}{8}$	$\frac{6}{5}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{15}{8}$	2

If the vibration frequency of the note *c* be represented by 1, the vibration frequencies of the other notes are represented by the numbers written under them.

The *interval* between any two notes is expressed by the *quotient* of their vibration frequencies and *not* by their subtraction; thus the interval between *f* and *a* is $\frac{5}{3} \div \frac{4}{3} = \frac{5}{4}$ and not $\frac{5}{3} - \frac{4}{3} = \frac{1}{3}$. Indicating the intervals between successive notes, the major mode may be written as follows:—

c	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
$\frac{9}{8}$	$\frac{10}{9}$	$\frac{16}{15}$	$\frac{9}{8}$	$\frac{10}{9}$	$\frac{9}{8}$	$\frac{16}{15}$	

[6] Bh. p. 445, *śloka* 18, where 'कोलाहलः कथिष्यति' ought to read 'कोहलः कथयिष्यति.' Also p. 446, v. 24, where कोहिलोदिभिरेवं तु is a misreading for कोहलादिभिरेवं तु. MS. A. confirms these corrections. This prediction, viz., that the rest not dealt with here will be treated by Kohala, plainly shows that this recasting of the Bh. was done after Kohala, a later author, had written his work.

[7] It may incidentally be mentioned that in Sârngadeva's enumeration of writers on music (*S. R.*, pp. 5-6) the name दुर्गाशक्ति occurs, which is the name of a single *man* (*S. R.*, p. 164). As printed in both editions of the *S. R.*, the reader is apt to imagine दुर्गा and शक्ति to be two distinct writers and *women*. The *Saṃgîta-pârijâta*, which is careless in such matters, actually mentions दुर्गा as an author. Similarly, the S. P. notwithstanding, perhaps रम्भार्जुन of *S. R.* is the name of a single individual, but I have no evidence, as in the other case, to support the conjecture.

[8] *Anecdotes of Indian Music* by Sir W. Ouseley, reprinted in Râjâ S. M. Tagore's *Hindu Music from Various Authors* (1882).

Each of the intervals $\frac{9}{8}$ and $\frac{10}{9}$ is called a tone. The former, which is the greater of the two, is further designated as a major tone and the latter a minor tone. The difference between the two is $\frac{9}{8} \div \frac{10}{9} = \frac{81}{80}$, which is called a comma. The interval 16/15 is called a semitone, or more strictly a diatonic semitone. Accurately speaking, it is slightly greater than a half tone, since two semitones $(\frac{16}{15} \times \frac{16}{15})$ are somewhat more than a tone $(\frac{9}{8})$. The minor tone $\frac{10}{9} = \frac{16}{15} \times \frac{25}{24}$, that is, it consists of a diatonic semitone $\frac{16}{15}$ and a somewhat smaller semitone $\frac{25}{24}$, which is called a chromatic semitone. When a note is raised or lowered by a chromatic semitone, it is said to be made *sharp* or *flat* respectively. Thus if the vibration frequency of *c* be taken as 1, $d = \frac{9}{8}$, *sharp* $d = \frac{9}{8} \times \frac{25}{24} = \frac{75}{64}$, *flat* $e = \frac{5}{4} \div \frac{25}{24} = \frac{6}{5}$, &c. *Sharps* and *flats* are indicated by the signs $\#$ and $\flat$ written after the notes, thus $d\,\#$ is *sharp d*, and $e\,\flat$ is *flat e*.

It is a well-known fact that the vibration frequency of a note (on which depends its pitch), obtained by plucking a thin string, is inversely proportional to its length, other things remaining the same.[9] If the length of the string producing the note *c* be taken as unity, the lengths which produce the different notes of the major mode will be as follows :—

Notes	*c*	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
Length of string	1	$\frac{8}{9}$	$\frac{4}{5}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{3}{5}$	$\frac{8}{15}$	$\frac{1}{2}$

Here again, as before, the difference or interval between two notes is represented by the *quotient* of the corresponding numbers and *not* by their *substraction*. Thus the interval between *d* and *e* is $\frac{4}{5} \div \frac{8}{9} = \frac{9}{10}$ (which means that the length of the string giving the note *e* is 9/10ths of that giving the note *d*, other things being the same), and *not* $\frac{8}{9} - \frac{4}{5} = \frac{4}{45}$. This is such an elementary matter that some readers are apt to wonder at the insistence with which it is presented here. But, as will be shown in the sequel, this error was actually made originally by J. D. Paterson, Râjâ S. M. Tagore drew up his instructions for the division of the finger board of the *S'rutivîṇa* in accordance with it, and Captain Day (to mention only the most important writer) gave further publication to it.

There is another and more convenient method of expressing the intervals between the different notes of a scale. On examining the scale given above, it will be seen that the interval between the fundamental note and its octave is divided into five tones and two semitones. Each tone is approximately equal to two semitones, and the interval of an octave may, therefore, be

[9] Though this can be experimentally demonstrated pretty accurately (exact precision is impossible) on a properly constructed monochord, for more than one reason errors are inevitable in an attempt to make the demonstration with the help of a fretted instrument like the *bîn* or *sitar*.

considered as equal to twelve semitones, and the intervals between the successive notes of the major mode may be roughly given in semitones as follows :—

Notes	...	...	...	...	*c*	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
Intervals in semitones	...	...			2	2	1	2	2	2	1	

This is evidently only a rough statement, as, strictly speaking, the interval between *c* and *d* is not equal to that between *d* and *e*, nor is either of them exactly double of that between *e* and *f*. But let us now suppose that the interval of an octave is subdivided into twelve *exactly equal* intervals, which we shall term 'equal semitones' (E. S.). Then evidently the interval of an octave $2 = (\text{E. S.})^{12}$, or one E. S. $= \sqrt[12]{2}$. Taking this as our unit, we can express any interval in terms of it. Thus the interval between *c* and *d* expressed as a quotient is $\frac{9}{8}$; and if we want to find the number of equal semitones x in the same, we have the relation $\sqrt[12]{2}^{x} = \frac{9}{8}$, which gives $x = 2.04$ nearly. To avoid decimals, we may put one *equal semitone* = 100 *cents*, and say that the interval between *c* and *d* is 204 cents, instead of 2.04 equal semitones. The pitch of the different notes of the major mode may now be expressed as follows:—

Notes...	...	*c*	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
Cents...	...	0	204	386	498	702	884	1088	1200

and the intervals between successive notes thus :—

Notes...	*c*	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
Cents...	204	182	112	204	182	204	112	

One convenience of this method of expressing the value of musical intervals is readily seen, *viz.*, that they can be expressed by means of differences instead of by quotients. Moreover, a comparison of different systems of dividing the octave is thereby rendered easier.

The Notes of Hindu Music.

From the S. R. I. iv. 38 and *Nâradî-Śikshâ* I. i. 2-3, it would appear that a *ṛik* was chanted in monotone, a *gâthâ* to two notes, and a *sâman* to three notes[10]. A scale of four notes also seems to have been in use and was called *svarântara* (Vern. *suratar*). In what relations of pitch the notes stood in the last three cases it is impossible to say, though at first in reading *Nâradî-Śikshâ* I. i. 9-13, and I. v. 1-2, one entertains a hope of being able to make a guess.

We are also ignorant of the stages by which the three notes of the *sâman*-chant rose to the number of seven, nor can we say, with certainty, what relation these seven *sâman* notes bore to the later seven notes of music. The former were named *krushṭa*, *prathama*, *dvitîya*, *tṛitîya*, *chaturtha*, *mandra* and *atisvâra*.[11] It is certain that these are in descending order of pitch,[12] but in what exact relation, it is impossible to say. The *Nâradî-Śikshâ* does indeed in one place say :—

यः सामगानां प्रथमः स वेणोर्मध्यमः स्वरः ।
यो द्वितीयः स गान्धारस्तृतीयस्त्वृषभः स्मृतः ॥१॥
चतुर्थः षड्ज इत्याहुः पञ्चमो धैवतो भवेत् ।
षष्ठो निषादो विज्ञेयः सप्तमः पञ्चमः स्मृतः ॥२॥

(*Translation*—The first note of the Sâman chanters is the *madhyama* of the flute, the second is the *gândhâra*, the third is known as the *ṛishabha*, the fourth is called the *shadja*, the fifth is the *dhaivata*, the sixth should be known as the *nishâda*, and the seventh the *pañchama*.)

[10] See also S. R. (*Calcutta*), p. 70, ll. 17 *et seq.*

[11] *Nâradî Śikshâ* I. i. 12; S. R. I. i. 25, Comm., where they are incorrectly spelt; A. C. Burnell's *Ârsheyabrâhmaṇa—The Sâman Chants* in S. M. Tagore's *Hindu Music from Various Authors*, 2nd edition.

[12] *Nâradî-Śikshâ*, I. vii. 1-2; A. C. Burnell *loc. cit.*

But it will be noticed that this nomenclature is different from the one which has just been referred to as being given in another part of the same work. As a matter of fact, the names of the seven notes of the *sâman* have varied from time to time and in different parts of the country,[13] the enumeration and notation by the first seven numerals being more modern. A. C. Burnell professes to have identified them by means of a standard pitch-pipe with *f, e, d, c, B, A, G*, and adds that 'it is also the doctrine of the *Nâradacixâ* (*adhy.* ii) according to oral information' and quotes the first of the two *ślokas* given above. He further remarks that 'the common Hindu scale corresponds with the European key of C.' But it is easy to show that Dr. Burnell is certainly wrong (1) either in his identification of the seven notes with *f, e, d*, &c., or (2) in supposing that this identification is borne out by the *Nâradî-śikshâ*. For, though the author is quite correct in saying that the common Hindu scale (that is, of the present day) corresponds with the European key of *C*, it does not follow that the common *ancient* Hindu scale was the same as to-day's. As a matter of fact, it will be shown in the sequel that if *c* be taken as the *shaḍja*, the *gândhâra* and the *nishâda* as given in all Sanskrit treatises on music, will be represented by *e* ♭ and *b* ♭, and not by *e* and *b* as is the modern Hindu practice in northern India. Moreover, Dr. Burnell evidently had not before him the second of the two *ślokas* quoted above; otherwise he would have seen that though the order was smooth up to the *fourth* note which was identified with the *shaḍja*, it was no longer so with the remaining notes, the fifth, sixth, and seventh, being the *dhaivata*, the *nishâda* and the *pañchama* respectively, and *not* the *nishâda*, the *dhaivata* and the *pañchama*, as one would expect if the enumeration of the notes had proceeded in the descending order of pitch. From all this it is evident that Dr. Burnell's identification of the seven notes of the *sâman*, even if it be correct, is not in accordance with the *Nâradî-śikshâ*, and it is very desirable that an expert should ascertain the relations of the notes of the *sâman*, while it is still possible to find Brâhmaṇas who can chant it.

Though we do not know all we desire about these notes, we can gather some information about the scale from their names. Thus it would appear that there was a time when only four notes were used, which were designated by the names the *first*, the *second*, the *third*, and the *fourth* and formed a descending scale, that at a later time the scale was extended below and upwards by the notes *mandra* and *krushṭa* respectively, and that *atisvâra* was the last addition to its lower end.

In music proper, designated by the term *gândharva*, seven notes are recognised and named *shaḍja*, *ṛishabha*, *gândhâra*, *madhyama*, *pañchama*, *dhaivata*, and *nishâda* (sometimes also called *saptama* or the seventh), and represented by the syllables *sa, ri, ga, ma, pa, dha*, and *ni* respectively. The earliest mention of these is found in the *Anugîtâ* and the *Garbhopanishad*. Telang assigns the former to the third or fourth century B. C., and the scale must be assumed to have dated from that period. How long before, the *sâman* scale of seven notes was in existence and whether it was identical with this one, are questions on which I am unable to throw light. In Greece, Pythagoras (flourished 540-510 B. C.) is said to have been the first to establish the eight complete degrees of the diatonic scale.

As regards the meaning of the names of notes, it is easy to see that the *madhyama* is so called because it forms the *middle* note, the *pañchama* because it is the *fifth*, and the *saptama* (another name for the *nishâda*) because it is the *seventh* note, in the *shaḍjagrâma*. The various derivations of these and the remaining notes given by different writers and quoted in the commentaries on the S. R. by Kallinâtha and Simhabhûpâla are simply fanciful, and need not be mentioned here. It may be noted, however, that one of the attempts, which interprets the name *shaḍja* as meaning 'the producer of the (other) six' (notes), besides being opposed to ordinary grammar,

[13] A. C. Burnell, *loc. cit.*

is based on the idea that it is the fundamental or keynote of the scale, which is incorrect; for, as will be shown hereafter, though *shaḍja* is the name of the keynote of the present Hindu scale, such was not the case in former times. The other explanation, *viz.*, 'the note derived from the (other) six' has the advantage of being in better agreement with grammar, and it is not impossible (though I do not consider it probable) that it might have been the last addition to the scale. The term *gândhâra* was evidently taken from the country of that name, noted for its musicians. The derivation of *nishâda* is stated to be from *ni*+√*sad*, the note being thus named because "the notes 'sit down' *i. e.*, end in this one."[14] This may be right, but I think it at least quite as likely that it was so called, because in the old Hindu *vîṇâ* (see below) the string on which it was played was the lowest, or as it were 'sat down.' The term *nishâdavân* is also sometimes applied to this note instead of "*nishâda*."

On the 'svaras' and 'śrutis.'

In the Bh. there is no confusion or want of clearness about these. But some of the later Sanskrit authors have introduced difficulties unnecessarily, which the reader will find discussed in Kallinâtha's commentary (S. R. pp. 34-36). Thus Viśvâvasu says that *śrutis* are of two kinds, *viz.*, (1) those on which the notes are located, and (2) those which intervene between two notes; for example, in the *shaḍjagrâma* the fourth, seventh, ninth, etc., *śrutis* will be said to belong to the first class, and the first, second, third, fifth, sixth, eighth, etc., to the second. Some mention sixty-six *śrutis*, *i. e.*, twenty-two for each of the three octaves, and have even gone to the extent of giving names to every one of these, others contenting themselves with naming only the twenty-two. In the Bh. the *śrutis* have not been designated by proper names at all. Some maintain that the number of *śrutis* is infinite, which statement, if it refers to the interval of an octave and is not merely an extension of the last view of sixty-six *śrutis* to the infinite number of octaves that are *conceivable*, simply means that the interval of an octave is divisible into an infinity of minute parts. Though this is true, it does not follow that one is not at liberty to divide it, if it suits one's purpose, into a desired number of parts. A straight line may be divisible into an infinite number of extremely minute parts, but it may be suitable for our purpose to divide it only into two or four. Kallinâtha's objection to the view of infinite *śrutis* is that the ear is incapable of appreciating such *infinitesimal śrutis*. Though this argument is quite valid, it does not strike at the root of the question. It may still be asked:—Why just twenty-two *śrutis*, and not twenty-four or twelve, each of which is quite as appreciable by the ear as one of the system of twenty-two? The only complete reply would be:—Simply because the system of twenty-two suits best the purpose in hand, which is to indicate the relations of the various notes in the *grâma*.

One more view requires notice. Kallinâtha[14] says "Other sages, like Vena, consider a *śruti* to be of nine sorts". Thus, for instance, 'At the holes of a flute wise men should produce notes of two, of three, and of four *śrutis*.' Bharata also has said[15] 'The notes in a flute should be known as of two, three, and four *śrutis*, (produced) by shaking (of the finger), by half opening (a hole), and by fully opening (it).[16] Thus have I mentioned nine correct *śrutis*.' I need hardly remark that it is arrant nonsense to speak of *śrutis* being of nine kinds, because there are notes of two, three, and four *śrutis*, and two, three and four together make nine! Further it must be added to the credit of the Bh. that the lines, which say so, though alleged to be from that work, are not found in any of the manuscripts I have consulted.

(To be continued.)

[14] S. R., Vol. I, p. 40, ll 3-4 (Kallinâtha's Comm.)

[15] S. R., p. 35. भरतेनाप्युक्तम्—द्विकत्रिकचतुष्कास्तु ज्ञेया वंशगताः स्वराः । कम्पमानार्धमुक्ताश्च व्यक्तमुक्ताङ्गुलिस्वराः ॥ इति तावन्मया प्रोक्ताः समीक्ष्यः श्रुतयो नव । इति ॥ व्यक्तमुक्तास्तथैव च is a better reading.

The ll. इति etc., do not occur in any of the MSS. of the Bh. I have consulted.

[16] In later verses in the Bh. it is explained that the notes obtained by these processes are of three, two and four *śrutis*, respectively.

CONTRIBUTION TO THE STUDY OF ANCIENT HINDU MUSIC.

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(*Continued from p. 164.*)

BUT if the *śrutis* have received such bad treatment from some Sanskrit authors, they have had a still worse fate at the hands of modern writers. Thus Sir W. Jones says[17]:—"If I understand the native musicians, they have not only the *chromatic*, but even the second, or new, *enharmonic*, genus; for they unanimously reckon twenty-two *śrutis*, or quarters and thirds of a tone, in their octave: they do not pretend that those minute intervals are mathematically equal, but consider them as equal in practice, and allot them to the several notes in the following order; to *sa*, *ma*, and *pa*, four; to *ri* and *dha*, three; to *ga* and *ni*, two; giving very smooth and significant names to each *śruti*. Their original scale, therefore, stands thus:

sa, *ri*, *ga*, *ma*, *pa*, *dha*, *ni*, *sa*,

4 *ś* 3 *ś* 2 *ś* 4 *ś* 4 *ś* 3 *ś* 2 *ś*

"The semi-tones accordingly are placed as in our diatonic scale; the intervals between the fourth and fifth, and between the first and second, are major tones; but that between the fifth and sixth, which is minor in our scale, appears to be major in theirs; and the two scales are made to coincide by taking a *śruti* from *pa* and adding to *dha*, or, in the language of *Indian* artists, by raising *Servaretnà*[18] to the class of *Síntà* and her sisters; for every *śruti* they consider as a little nymph, and the nymphs of the *Panchama*, or the *fifth* note, are *Málinì*, *Chapalá*, *Lólá* and *Servaretnà*, while *Sántá* and her two sisters regularly belong to *Dhaivata*: such at least is the system of CÓHALA, one of the ancient bards, who has left a treatise on music.

"SÓMA seems to admit, that a quarter or a third of a tone cannot be separately and distinctly heard from the *Vinà*; but he takes for granted, that its effect is very perceptible in their arrangement of modes; and their sixth, I imagine, is almost universally diminished by one *śruti*; for he only mentions two modes, in which all the seven notes are *unaltered*. I tried in vain to discover any difference in practice between the *Indian* scale, and that of our own; but knowing my ear to be very insufficiently exercised, I requested a *German* professor of music to accompany with his violin a *Hindu* lutanist, who sung *by note* some popular airs on the loves of CRISHNA and RÁDHÁ; he assured me, that the scales were the same; and Mr. SHORE afterwards informed me, that, when the voice of a native singer was in tune with his harpsichord, he found the *Hindu* series of seven notes to ascend, like ours, by a sharp third."

Now I can well believe the inability of Sir W. Jones to discover any difference between the Indian and European scales, and the German professor's confirmation of their unity. For, *practically*, the present-day Hindu scale[19] may be considered indistinguishable from the modern European scale, and Mr. Shore is quite right when he says that it ascends, like the other, by 'a sharp third' (major third). But that is about the only correct thing in this passage, almost all other assertions being errors, which have since been repeated by other writers, who have accepted them without examination. It is necessary therefore, to point them out here *seriatim*:

(1) In the first place it must be obvious to the reader that no one has a right to *assume* that the scale mentioned in Sanskrit treatises is the same as that of the present day. As a matter of fact, it will be shown in the sequel that they differ.

[17] *On the Musical Modes of the Hindus* (*Works Vol. IV.*)

[18] The names of the *śrutis* given by Sir W. Jones differ from those commonly found in Sanskrit treatises. Were they taken from *Saṁgîta-Nârâyaṇa?*

[19] Whenever the present-day Hindu scale is referred to in this essay, it should be clearly understood that the present Hindustânî system of music is in view, and not the present Carnatic system, unless the contrary is expressly stated.

(2) Secondly, it is wrong to infer that the Hindus had the *enharmonic* genus of the Greeks or anything similar to it, because they unanimously reckon twenty-two *śrutis* in their octave. In the *Preliminary Remarks* above, the European scale is given in cents, twelve hundred being reckoned in the octave; but it would be absurd to argue therefrom that the Europeans have a genus in which the notes ascend by single cents.

(3) Thirdly, (*a*) thinking that the scheme of the scale as given by Sanskrit authors was

sa	*ṛi*	*ga*	*ma*	*pa*	*dha*	*ni*	*sa*
4 *ś*	3 *ś*	2 *ś*	4 *ś*	4 *ś*	3 *ś*	2 *ś*	

which is an error, as will be shown presently, and (*b*) finding the *prevailing* Hindu scale and the modern European major scale indistinguishable,[20] and (*c*) noticing three sorts of intervals in the classical Hindu scale,[21] and (*d*) observing them (owing to his erroneous scheme of the scale) to occupy, as regards their comparative magnitudes, the same places as the major tone, the minor tone, and the semitone in the European scale, except in one instance (*viz.*, the interval between the fifth and the sixth), Sir W. Jones naturally succumbed to the temptation of looking upon the two scales as quite identical, and made the *assertions* that the four-, three-, and two-*śrutis* intervals were respectively the major tone, the minor tone and the semitone. But the three-*śrutis* interval was a stumbling block. As this interval was identified with a tone, a *śruti* had to be considered as a third of a tone; at the same time, the four-*śrutis* interval being looked upon as a major tone, a *śruti* had also to be supposed to be equivalent to a quarter of a tone. If the value of a *śruti*, however, be admitted to be thus uncertain, of what use could such a variable standard be? If an inch be sometimes a twelfth of the foot and sometimes only a sixteenth, how could it ever be of use as a measuring unit? Sir W. Jones seems to have thought that he had effectually got out of the dilemma by saying:—"they do not pretend that those minute intervals are mathematically equal, but consider them as equal in practice." He seems to be unconscious of the fact that we cannot possibly consider a quarter-tone and a third of a tone as equal in practice, and choose either indifferently as the equivalent of a *śruti* in the classical Hindu scale and yet make the scale coincide with the European. Thus, if we suppose a *śruti* to be a quarter of a major tone, *i.e.*, 51 cents (see above), the value of the three-, and two-*śrutis* intervals will respectively be 153 and 102 cents, that is, even though the two-*śrutis* interval may be allowed to pass as practically equal to the diatonic semitone of 112 cents, the three-*śrutis* interval cannot be taken as equal to the minor tone of 182 cents. On the other hand, if we take a *śruti* as a third of a minor tone, *i.e.*, 61 cents, the four- and two-*śrutis* intervals will respectively be 244 and 122 cents; and here again even though we considered the two-*śrutis* interval as practically equal to the diatonic semitone of 112 cents, the same cannot be said of the four-*śrutis* interval and the major tone of 204 cents.[22] But the amount of error becomes still more pronounced, when we remember (as will be pointed out later on) that the old Sanskrit musicians were much more concerned about their just[23] fourths and fifths than about their seconds, and when accordingly we find their value on the hypothesis of Sir W. Jones.

[20] I have allowed the two scales to be *practically* the same, but when anybody wishes to establish the identity in detail, as for instance with regard to major and minor tones, he must produce stronger experimental evidence than Sir W. Jones has done.

[21] Hereafter I shall use the name 'classical Hindu scale' to mean the (*Shadja*) scale given in Sanskrit treatises. The term 'ancient or old scale' is not suitable, for even in modern Sanskrit books it continued to be taken as the standard, though there is reason to believe that it was not the *prevailing* scale, which in its turn could, of course, be expressed in terms of the standard. I know of Sanskrit books on music composed in the last few years in which the classical Hindu scale is taken as the standard, though it is no longer the standard in practice.

[22] As will be seen hereafter, the fact is that a *śruti* must be looked upon as practically invariable, like all other standards, with the result that the classical Hindu scale cannot be the same as the European one, even allowing that Sir W. Jones' scheme of the former as given above is correct.

[23] All the fourths and fifths of the classical scale are not just, only those with the intervals of nine and thirteen *śrutis* respectively being allowed to be so (*vide seq.*).

		Value of the Fourth in cents.	Value of the Fifth in cents.
Just		498	702
Acc. to Sir W. Jones	When 1 *śruti* = ¼ major tone = 51 cents ...	459	663
	When 1 *śruti* = 1/3 minor tone = 60 2/3 cents.	546	789
Acc. to Sanskrit writers	When 1 *śruti* = 1/22 octave = 54 6/11 cents	491	709

A glance at the table shows that whereas in the Hindu system of 22 *śrutis* in the octave, the error amounts to only 7 cents or about a third of a *comma*, on Sir W. Jones' *assumptions* it is six to twelve times as great.

(4) So great is the anxiety of Sir William to establish the identity of the classical Hindu and the European major scale that, though in accordance with his (erroneous) scheme of the former he is forced to admit that the interval between the fifth and the sixth in that scale is a major tone whereas it is a minor tone in the other, he proceeds to add—"their sixth, I imagine, is almost universally diminished by one *śruti*" [thus making the two scales coincide]; "for he [Somanâtha] only mentions two modes, in which all the seven notes are *unaltered*." Now even admitting that according to Somanâtha, there are only two modes in which all the seven notes are unaltered,[24] how does it follow that in almost all the remaining modes the sixth is altered? To take an extreme view, the statement of Somanâtha can be quite correct without a single one of the remaining *râgas* having an altered sixth, the alterations being confined to one or more of the other notes. Sir W. Jones' imagination that the sixth of the classical Hindu scale is 'almost universally diminished by one *śruti*,' is a mere assertion, which he makes in order to uphold his preconceived notion of the identity of the two scales, but for the support of which he has produced no evidence.[25]

(5) Lastly comes the most serious error of all, which is in fact the source of all the others. Sir W. Jones would have found, if he had been a little more careful, that he had made a mistake in assigning proper places to the groups of *śrutis*. All Sanskrit treatises clearly give the following as the scheme of the *shadja-grâma*:—

[*ni*]	*sa*	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	[*sa*]
4 *ś*	3 *ś*	2 *ś*	4 *ś*	4 *ś*	3 *ś*	2 *ś*	4 *ś*	

Correct scheme of the *shadja-grâma*.

But Sir W. Jones made the mistake of putting *after* the notes the different groups of *śrutis* attached to them, whereas according to rules they ought to have been put *before* them. Thus he wrongly represented the scheme as follows:—

sa	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	*sa*
4 *ś*	3 *ś*	2 *ś*	4 *ś*	4 *ś*	3 *ś*	2 *ś*	

Sir W. Jones' incorrect scheme of the *shadja-grâma*.

This great error together with the others mentioned above, of which it was the source, has found its way in the writings of all subsequent authors, among whom are Sir W. Ouseley, Mr. J. D. Paterson, W. C. Stafford, Capt. Willard, Col. French, Carl Engel, Râjâ S. M. Tagore, J. Grosset, A. J. Ellis,[26] A. W. Ambros[27] and Capt. Day, to mention only the most important. This propagation of error was quite natural, as most of the writers were ignorant of Sanskrit. But they re-iterated the words of Sir W. Jones with so much force and perseverance, and with such an appearance of independent research that a conscientious scholar like M. J. Grosset, who was the

[24] Somanâtha defines only two *râgas* viz. *mukhâri* and *turushki-todi* with all seven notes unaltered (R. V. iv.8), but he admits the existence of other *râgas* with similarly unaltered notes (R. V. iii. 32). At the same time the student of the R. V. will easily see that the unaltered notes according to Somanâtha are quite different from those according to Sir W. Jones.

[25] In the correct scheme of the classical Hindu scale given below, it will be seen that the interval between *pa* and *dha* is only three *śrutis* and not four as Sir W. Jones made out.

[26] In his translation of *Helmholtz's Sensations of Tone*, 3rd edition, p. 521. [27] *Geschichte der Musik*.

first to go back to the most ancient of Sanskrit treatises on music, was actually misled by them. This was very unfortunate, as he thereby missed the opportunity of correcting the prevalent error, and actually thought Bharata to be wrong in certain places, where he was quite correct.[28] Thus finding the order of *śrutis* given in the Bh. different from that given by Sir W. Jones, he thought that the discrepancy was probably due to the exigency of the metre.[29] The first person to detect the error was Râjâ S. M. Tagore, who had himself previously given currency to it in his own writings.[30] But, unfortunately, instead of acknowledging it as such, he tries to defend it and in doing so falls into fresh errors.[31] Thus he says: "In the arrangement of the *Srutis*, modern usage is diametrically opposite to the classical one; the latter placing them before the Notes to which they respectively belong, while the former fix their position after the Notes. Supposing a cypher to represent a *Śruti*, the classical arrangement would be like this:—

0 0 0 0	0 0 0	0 0	0 0 0 0	0 0 0 0	0 0 0	0 0
sa	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*

The modern arrangement is as follows:—

0 0 0 0	0 0 0	0 0	0 0 0 0	0 0 0 0	0 0 0	0 0
sa	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*

"It is difficult to determine when or by whom the alteration in the arrangement was effected. The arrangement of the frets on the *Vinâ* and other stringed instruments accords with the modern acceptation of the principle. It will be seen from a look at these instruments, that, in them *Gándhára* and *Nishâda*, each of which has two *Śrutis*, and is called in European music a semitone, have, between themselves and the succeeding notes, half the space that is allotted to those having four *Śrutis*; and following the same method, *Rishabha* and *Dhaivata*, have, with reference to the next succeeding *Notes*, each a fourth less than that of *Shadja*, *Madhyama*, and *Panchama* (each of which has four *Śrutis*). According to a rule laid down in the classical treatises, the disposition of the notes is reversed in the case of *Dâravî* (literally, wooden, *i. e.*, stringed) instruments, and out of this reversed arrangement, perhaps, the modern theory about the arrangement of the position of the *Śrutis* has been evolved." Then in a footnote he adds:—"Capt. Willard, Sir W. Jones, and other eminent writers, who had carefully studied the principles of Indian Music and were practically acquainted with it, adopted the modern disposition of the *Śrutis*."

Now in this passage the only statements which are correct are (1) that the classical arrangement of the *śrutis* in the *śrutijâti* is as given there, and not as was given by former writers and by the Raja himself in his previous works and (2) that in the classical arrangement the semitones were between *ri* and *ga*, and between *dha* and *ni*,[32] and that in the modern arrangement they are between *ga* and *ma*, and between *ni* and *sa*. All else is wrong. He had no right to assert that the erroneous scheme was 'the modern acceptation of the principle,' without quoting his authority for it. Then he adds that the modern arrangement of the frets on the *vîṇâ* and other stringed instruments accords with it, for, he says, that if the space between the frets *sa* and *ri*, *ma* and *pa*, and *pa* and *dha* be taken as four units, that between the frets *ri* and *ga*, and *dha* and *ni* is three, and that between *ga* and *ma*, and *ni* and *sa* two. I need hardly remark that all this is quite

[28] J. Grosset—*Contrib. à l'Étude de la Musique Hindoue*, p. 84, notes 27 and 28.

[29] *Opus cit.* p. 85, note 34.

[30] '*Hindu Music*' 1874; *Six Principal Rágas*, 2nd edition, 1877.

[31] *Musical Scales of the Hindus*, 1884, pp. 93-94.

[32] The reader should note carefully that I say that the semitones were between *ri* and *ga*, and *dha* and *ni*, and not between the second and third notes, and the sixth and seventh notes, respectively, because, as will be pointed out hereafter, the classical *sa* was not the first of the scale *in the same sense* as the present day *sa* is.

wrong, as anybody with some acquaintance of the elements of acoustics can easily see.[33] The same sort of gross mistake had been committed previously by J. D. Paterson,[34] with this difference that this writer saw that even with his naive rejection of fractions, which he resorted to with apparent success in the first tetrachord *sa—ma*, he could not get anywhere near the numbers he desired in the case of the distances between successive frets of the second tetrachord *pa—sa*, and had recourse to the very ingenious suggestion that 'as they considered the 2nd Tetrachord as perfectly similar to the first, they probably made use of the same numbers to express that similitude.' Verily scholarship must have been comfortably unexacting in those happy old days!

There is thus absolutely no basis for Râjâ S. M. Tagore's fancied modern arrangement of the *śrutis*, there being no authority for it. Nor does the observed difference in the position of the semitones in the classical and the modern scales stand in need of such an hypothesis, as it is capable of more than one other explanation as will be seen hereafter. But in putting forward a probable explanation of the supposed displacement of the *śrutis*, the writer says: 'According to a rule laid down in the classical treatises, the disposition of the notes is reversed in the case of *Dáravi* (literally, wooden, *i. e.*, stringed) instruments, and out of this reversed arrangement, perhaps, the modern theory about the arrangement of the position of the *śrutis* has been evolved.' As usual the Râjâ does not quote his authority, but it seems certain that he is referring to the lines

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[33] If we suppose with the Râjâ the length of the string producing *sa* to be 90 inches, then theoretically the lengths giving the succeeding seven notes of the octave [on the Râjâ's *assumptions* about (1) the disposition of the *śrutis* in the modern Hindu scale and (2) the values of the three sorts of intervals being a major tone, a minor tone and a diatonic semitone] will be 80, 72, 67½, 60, 53⅓, 48 and 45 inches respectively, and the difference in lengths of strings will be as shown in the following table:—

4 *śrutis*	*sa* and *ri* 10 inches	3 *śrutis*	*ri* and *ga* 8 inches	2 *śrutis*	*ga* and *ma* 4½ inches.
	ma and *pa* 7½ ,,		*dha* and *ni* 5⅓ ,,		*ni* and *sa* 3 ,,
	pa and *dha* 6⅔ ,,				

A mere glance at the table shows the error of the Râjâ's statement. The fact is that there is a radical error in representing musical intervals by *differences* in the lengths of strings producing the notes. The correct way to represent them is by means of *quotients* of the respective lengths. Thus the 4-*śrutis* intervals above are $\frac{90}{80} = \frac{67\frac{1}{2}}{60} = \frac{60}{53\frac{1}{3}} = \frac{9}{8}$; 3-*śrutis* $\frac{80}{72} = \frac{53\frac{1}{3}}{48} = \frac{10}{9}$; 2-*śrutis* $\frac{72}{67\frac{1}{2}} = \frac{48}{45} = \frac{16}{15}$. See the *Preliminary Remarks* above.

[34] *On the Grâmas or Musical Scales of the Hindus* (*Asiatic Researches, Vol. IX*), reprinted in Tagore's *Hindu Music from Various Authors*, and quoted in Capt. Day's *The Music and Musical Instruments of S. India and the Deccan*. What J. D. Paterson says amounts to this:—The *madhyama-grâma* is formed from the *shadja-grâma* (see Sir W. Jones' scheme above) by flattening *dha* by one *śruti*, which thus becomes identical with the major mode of European diatonic scale (of course, according to the wrong notions of that author and Sir W Jones). Now take a sounding string 44 units in length between the nut and the bridge; then half the length or 22 units will give the octave of the open string, representing the 22 *śrutis*. The lengths for the different notes will theoretically be as follows:—

Note	1	2	3	4	5	6	7	8 or octave.
Length of string ...	44	$44 \times \frac{8}{9}$	$44 \times \frac{4}{5}$	$44 \times \frac{3}{4}$	$44 \times \frac{2}{3}$	$44 \times \frac{3}{5}$	$44 \times \frac{8}{15}$	$44 \times \frac{1}{2}$
Difference in length of strings of successive notes.	$4\frac{8}{9}$	$3\frac{41}{45}$	$2\frac{1}{5}$	$3\frac{2}{3}$	$2\frac{14}{15}$	$2\frac{14}{15}$	$1\frac{7}{15}$	

Reject the fractions of the first three differences, says Mr. Paterson, and you have the figures 4, 3, and 2 respectively, the number of *śrutis* supposed to be there by the Hindu musicians. But the remaining figures do not fit in, even with the extreme liberality with which the reader has been asked to reject fractions, and the author has, therefore, recourse to the ingenious suggestion given above. Not to mention the hugeness of fractions omitted, it will be at once seen that the writer's way of representing musical intervals is radically wrong (see the last footnote).

एवं शारीरवीणायां दारव्यां तु विपर्ययः । and in that case it is evident that he has misinterpreted them, probably because he had not before him the context. The passage runs as follows :—

इति वस्तुस्थितिस्तावद्गात्रे त्रेधा भवेदसौ । [असौ नादः]
हृदि मन्द्रो गले मध्यो मूर्ध्नि तार इति क्रमात् ॥
द्विगुणः पूर्वपूर्वस्मादयं स्यादुत्तरोत्तरः ।
एवं शारीरवीणायां दारव्यां तु विपर्ययः ॥ (*Saṃgita-darpaṇa* I. 49-50)

It simply means that in the case of the 'body-vîṇâ' the pitch rises as you go higher and higher (thus it is low in the chest, middle in the throat, and high in the head),[35] whereas it is just the reverse in the case of a wooden *vîṇâ*, that is to say the pitch rises as you go lower and lower on the instrument. The reader will at once see that this has no connection whatsoever with the supposed sliding of the *śrutis*.

Again, when the author proceeds to defend 'Capt. Willard, Sir W. Jones, and other eminent writers' by saying that they 'adopted the modern disposition of the *Srutis*', he is not adhering to facts ; for a reference to the writings of Sir W. Jones will show that he was writing on the authority of Sanskrit treatises, none of which speak of the so-called 'modern disposition of the *Śrutis*.'

Lastly, it is curious to note that even when the Râjâ has made the discovery of the correct arrangement of the *śrutis* in the classical scale and published it in his *Musical Scales of the Hindus*, he gives in the Supplement to the same work a drawing, said to be executed for him by a European friend, which, though labelled '*The Primitive Sanskrit Sharja-gráma*,' is nothing more or less than Sir W. Jones' original misinterpretation of that scale.[36]

In all this confusion of assumptions and assertions without authority or evidence, it is a relief to find one writer take a correct view of the nature of the *śrutis*. Mr. R. H. M. Bosanquet[37] reveals a wonderful clearness of vision when he writes :—'Are the *śrutis* all equal in value ? The native writers say nothing about this, but the European ones for the most part suggest that they are not. For instance, an English reviewer recently wrote, "A *śruti* is a quarter tone or a third of a tone according to its position in the scale." This appears to be a misapprehension arising from the modern idea that each interval of a tone in the scale is necessarily the same. But the language in which the different forms of the scale is [? are] described distinctly indicates that a note rises or falls when it gains or loses a Sruti ; consequently we may infer that the Srutis are intended to be equal in a general sort of way, probably without any very great precision.'[38] But so great was the influence of the writings of Sir W. Jones (probably because he was a Sanskrit scholar) and Râjâ S. M. Tagore (probably because he was a Hindu writer) that one need not be surprised at the following criticism on his paper by Capt. Day, who happens to be neither :—'This calculation of Mr. Bosanquet's was made on the assumption that all the srutis were equal. That such could not have been in reality the case, or that the employment of the system of twenty-two never entered practically into Indian music, would seem to be from all evidence almost certain.

[35] Of course, this is the Hindu belief, according to which low-pitched notes proceed from the chest, those of middle pitch from the throat, and those of high pitch from the head.

[36] *On the Musical Modes of the Hindus* (*Works* Vol. IV, p. 189 ; reprinted in *Hindu Music from Various Authors*, 2nd edn. p. 141.)

[37] *On the Hindu Division of the Octave, etc.* Jan. 1877 (*Proceedings of the Royal Society of London*), quoted in Tagore's *Hindu Music from Various Authors* 2nd, edition.

[38] The perfect truth of this inference will be evident in the sequel, where it will be established on the authority of Sanskrit treatises.

'This will be more evident by a reference to the following comparative diagram of the primitive Sanskrit shadja-gráma and the European diatonic scale, as drawn for the Râjah Sir S. M. Tagore, and published in his work upon the "Musical Scales of the Hindus" from data supplied by the ancient treatises, the measurements being those of a string 90 inches long[39].'

'The only difference, it will be seen, is in the fact that the sixth is in the European diatonic scale flatter than in the ancient one; so that the ancient Sanskrit sixth had apparently the same ratio, theoretically, as the Pythagorean sixth of the Greeks.'

Of course, Capt. Day is under a delusion when he says that the Raja's diagram was drawn 'from data supplied by the ancient treatises.' It is, as I have said above, nothing more or less than Sir W. Jones' original misinterpretation of the *shadja-grâma*.[40]

Capt. Day was not the only person who was thus misled. Others were similarly led into error, the most notable of whom was Mr. A. J. Ellis, who writes as follows[41]:—[Scales] 'Nos. 73 and 74 are an attempt to represent the Indian Chromatic Scale from indications in Rajah Sourindro Mohun Tagore's *Musical Scales of the Hindus*, Calcutta, 1884, and the *Annuaire du Conservatoire de Bruxelles*, 1878, pp. 161-169, the latter having been drawn up by Mons. V. Mahillon from information furnished by the Rajah. As regards the 7 *fixed* notes (*prakritâ*) of the *C* scale (*sharja gráma*), *C, D, E, F, G, A* (a comma sharper than our A_1),[42] *B*, there seems to be no doubt of the theoretical values. As to the 12 *changing* notes (*vikritâ*), the values given can be considered only as approximative. The division of the intervals of a major Tone of 204 cents into 4 degrees (*śrutis*); of a minor tone of 182 cents into 3 degrees; and of a Semitone of 112 cents into 2 degrees, as indicated by the superscribed numbers, is also certain.[43] But whether the 4 parts of a whole Tone were equal and each 51 cents, and the three parts of a minor Tone were also equal and each equal to $60\frac{2}{3}$ cents, and the two parts of a Semitone were also equal and each therefore 56 cents, is quite uncertain.' Mr. A. J. Hipkins, who worked with Mr. A. J. Ellis in examining an Indian *vîṇâ*, and the *śruti-vîṇâ* imagined by Râjâ S. M. Tagore, shows a clearer insight into the matter, when, in a communication to Capt. Day,[44] he remarks that the Indian scale intervals ought to be understood as they are explained by native writers—namely, as a tone, a $\frac{3}{4}$-tone and a $\frac{1}{2}$-tone, composed of 4, 3 and 2 śrutis respectively.[45] Besides Mr. Bosanquet he seems to be the only person who grasped the truth amidst groundless erroneous assertions. Unfortunately as regards the disposition of the *śrutis* in the scale he is unaware of the mistake made by previous writers, to which I have so often referred, and accepts it, together with its unfailing accompaniment of a *dha*, sharper by a comma than the *A* of the European scale of just intonation.

[39] I have omitted the diagram.

[40] In justice to the Râjâ himself it must be admitted that he does not claim that the diagram was drawn 'from data supplied by the ancient treatises', and in equal justice to Capt. Day it must be remarked that the Râjâ unfortunately writes in a manner, which suggests that he has got the ancient Sanskrit treatises at his back in what he has to say. Thus in the present instance the adjectives 'Primitive Sanskrit' applied to the scale probably misled Capt. Day.

[41] In his translation of Helmholtz's work, 3rd edition, p. 521.

[42] The reader will at once recognise in this the same ghost, which was originally raised by Sir W. Jones and subsequently owned and exhibited by Râjâ S. M. Tagore, only clothed in language of apparently greater precision. For, Sir W. Jones thought the interval between *pa* and *dha* to be a major tone, whereas that between *G* and *A* (to which they were supposed to correspond) is a minor tone, the difference between the two being a comma.

[43] This again is simply a re-iteration of Sir W. Jones' error which has been exposed above.

[44] *The Music of Southern India*, p. 21.

[45] Subject to a correction (which will be explained below) based on the authority of Sanskrit writers themselves.

To sum up, we have :

(1) The erroneous inference that the Hindus had the *enharmonic* genus, because they reckoned twenty-two *śrutis* in the octave.

(2) The original error of Sir W. Jones in placing the various *śrutis* (in the *shaḍja-grâma*) *after* the notes, instead of *before* them, as required by *all* Sanskrit treatises on music.

(3) Sir W. Jones' groundless identification of this erroneous scale with the European Diatonic Scale of just intonation, with the exception of *dha* which was supposed to be a *śruti* sharper. Sir W. Jones further thought, on mistaken grounds, that probably even this difference in the two scales did not exist in practice.

(4) As a result of these errors the two statements made by the writer (1) that a *śruti* was sometimes a quarter tone and sometimes a third of a tone, and (2) that the *śrutis* were equal in practice, without perceiving the contradiction involved therein.

(5) Acceptance of all these erroneous statements by subsequent writers without examination. Only the suggestion that probably the sixth notes even were in practice identical in the two scales was neglected, and the supposed augmentation of *dha* in the *shaḍja-grâma* was so often re-iterated that it came to be believed in as though based on Sanskrit texts. Similarly, the equality of the *śrutis* in practice, vouched for by Sir W. Jones, was lost sight of and only his other statement, *viz.*, that at times a *śruti* was a quarter tone and at others a third of a tone continued to be repeated.

(6) Mr. Paterson's and Râjâ S. M. Tagore's mistaken notion that intervals in *śrutis* between two notes were proportional to the *difference* in the sounding lengths of the string producing the notes.

(7) Recognition by Mr. Bosanquet and Mr. A. J. Hipkins that the *śrutis* were intended to be equal in a general sort of way.

Lastly, in this connection I may mention that quite recently a Hindu writer has been seriously maintaining that a *śruti* is not a unit of measurement at all!

Amidst all this confusion let us see what Sanskrit treatises on music, beginning with the oldest, *viz.*, the *Bhâratiya-nâṭya-śâstra*, say in the matter.

At the very outset it may be remarked that, as noticed by Mr. Bosanquet, even with the information available in his time the *śrutis* must be regarded as 'equal in a general sort of way, probably without any very great precision.' As shown above, it is as absurd to speak of a *śruti* being sometimes a quarter-tone and at others a third of a tone as to say that an inch is sometimes a twelfth of a foot and sometimes a sixteenth. It is possible that quantities to be estimated may be such that they cannot be very accurately measured with the standard unit chosen, but the intention is clear that the standard unit is to be looked upon as invariable. Even Sir W. Jones, with whom originated the notion of the variability of a *śruti*, admitted that the *śrutis* were considered 'as equal in practice.' It seems strange, therefore, that the writers who followed him should have accepted just the wrong notion and ignored the other one. But if anybody be still in doubt about the *śruti* being a unit of measurement and consequently possessed of a fixed value, it ought to be removed by the explicit statement to that effect in the Bh. After giving the constitution of the *shaḍja-grâma* as follows:—

sa	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	*sa*
3½	2½	4½	4½	3½	2½	4½	

it adds "But in the *madhyamagrâma* the *pañchama* should be diminished by a *śruti*. The magnitude of a *śruti* is the interval due to the sharpening or flattening [produced] by the augmentation

or diminution of the *pañchama* by a *śruti*."[46] Mataṅga, a much later author, also says the same:—"What indeed is the magnitude of a *śruti*? I tell you. The *pañchama*, now, as belonging to both *grâmas* is known to all. The interval due to the sharpening or flattening by its augmentation or diminution is the magnitude of a *śruti*."[47] Bharata, moreover, proceeds to an exposition of the *śrutis* by means of an illustration, in which he asks the reader to get two exactly similar *vîṇâs*, tuned to the *shaḍja-grâma*, and having the same succession of seven notes (मूर्छना); then "Making one of the two *vîṇâs madhyamagrâmikî* (*i.e.*, converting its tuning to that of the *madhyamagrâma*) lower the *pañchama* by a *śruti*.[48] Under the influence of the (lowered) *pañchama* (*i. e.*, keeping it unchanged) make the very same (*vîṇâ*) *shaḍjagrâmikî* (tuned to the *shaḍja-grâma*).[49] Thus is one *śruti* diminished. Once more do the lowering just in the same way; so will the *gândhâra* and the *nishâda* enter (*i.e.*, come to be in unison with) the *ṛishabha* and the *dhaivata* (respectively) in the other (*vînâ*), owing to their being two *śrutis* higher (than these). By lowering again just in the same way, the *dhaivata* and the *ṛishabha* enter (*i.e.*, come to be in unison with) the *pañchama* and the *shaḍja* (respectively), owing to their being three *śrutis* higher (than these). It (the *vîṇâ*) being again lowered in the same way, the *pañchama*, the *madhyama* and the *shaḍja* will enter (*i. e.*, come to be in unison with) the *madhyama*, the *gândhâra* and the *nishâda* (respectively) in the other (*vîṇâ*), owing to their being four *śrutis* higher (than these). Thus by this illustration (or proof) should be understood the twenty-two *śrutis* in the two *grâmas*."[50] From all this it ought to be perfectly

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[46] मध्यमग्रामे तु श्रुत्यपकृष्टः पञ्चमः कार्यः । पञ्चमश्रुत्युत्कर्षादपकर्षाद्वा यदन्तरं मार्दवादायतत्वाद्वा तत्प्रमाणा श्रुतिः । A. If मार्दवम् is 'flattening' and आयतत्वम् is 'sharpening,' the arrangement of these words in this quotation as well as in the next (see footnote below) ought to be reversed. The former word occurs again in the *Bh.* (p. 306, l. 14), and in a quotation from Mataṅga's work in Simhabhûpâla's comm. on the *S. R.* (Calcutta edn. p. 68), where it clearly means 'flattening,' and the modern usage is also the same. But in the *Bh.* p. 320, *śloka* 39, we have आयतत्वं तु चेन्नीचं[चे] मृदुत्वं तु विपर्ययम् [॰ र्यये]। The same *śloka* with a slight variation occurs in the *Nâradî-śikshâ*, and the corrections in the rectangular brackets are according to that authority. The verse, as occurring in the *Bh.*, is out of place and is not found in A. and G.; but according to it, मार्दवम् and आयतत्वम् would mean 'sharpening' and 'flattening' respectively, *i. e*, just the opposite of what is given above as the meaning. But I have nowhere else found the term मार्दवम् used to signify 'sharpening.'

[47] श्रुतेः प्रमाणमुक्तं मतङ्गेन । ननु श्रुतेः किं मानम् । उच्यते । पञ्चमस्तावद् ग्रामद्वयस्थो लोके प्रसिद्धः । तस्यात्कर्षेपापकर्षणभ्यां मार्दवादायतत्वाद्वा यदन्तरं तत्प्रमाणश्रुतिरिति । (Simhabhûpâla's comm. on the *S. R.*, p. 43, Calcutta).

[48] This could be easily done by making the *pañchama* consonant with the *ṛishabha* (*i. e.*, a just fourth), which it is not in the *shaḍja-grâma* (see below for *consonances*).

[49] Of course, by lowering the pitch of the other strings.

[50] To start with, both *vîṇâs* A and B were tuned to the *shaḍja-grâma*. The tuning of one of them B was changed to that of the *madhyamagrâma* by simply lowering its *pañchama* by the necessary amount (*viz.*, to make it the exact fourth of the *ṛishabha*). This amount of flattening is to be called a *śruti*. Keep this pitch of the *pañchama* constant and convert the tuning of B to that of the *shaḍjagrâma*, which of course, will have to be done by lowering the other notes by the necessary quantities. It is evident that the *whole vîṇâ* B is now tuned a *śruti* lower than A. Repeat the operations once more, *i. e.*, convert the tuning of B to that of the *madhyamagrâma* by lowering the *pañchama*, and then keeping this *pañchama* constant once more convert the tuning back into that of the *shaḍja-grâma*. It will be again necessary to lower the other notes by proper amounts, and the *whole vînâ* B will now be tuned *two śrutis* lower than A. But at this stage it will be discovered that the notes produced by the *gândhâra* and *nishâda* strings of B will be in unison respectively with those produced by the *ṛishabha* and *dhaivata* strings of A. Thus it is proved that the *gândhâra* and the *nishâda* possess each of them two *śrutis*. Similar reasoning will prove that the *ṛishabha* and *dhaivata* possess each

clear that a *śruti* is a measure of musical interval, and all *śrutis* were intended to be equal. The illustration by means of two *vîṇâs*, one with fixed notes and the other with variable ones, given in the *S. R.*, though defective from another point of view, also proves the same thing.[51]

In the Bh. the twenty-two *śrutis* have no distinctive names. In later works we find them named, the most commonly accepted names being those given in the *S. R.* The *Saṃgîta-samaya-sâra*, quoted by Simhabhûpâla, gives a name to each of the sixty-six *śrutis* comprised in the three octaves.[52] Similarly there is no mention in the *Bh.* of the so-called five kinds (*jâti*) of *śrutis*, *viz.*, *dîptâ*, *âyatâ*, *karuṇâ*, *mṛidu*, and *madhyâ*, found in later writers. What was intended by this classification of *śrutis* I am unable to say. The *S. R.* gives no explanation, but the *Nâradî-śikshâ* contains some verses in this connection, which I give below without pretending to understand them to any great extent. The notes are those used in *sâman* chants and mentioned above.

दीप्ताऽऽयताकरुणानां मृदुमध्यमयोस्तथा ।
श्रुतीनां योऽविशेषज्ञो न स आचार्य उच्यते ॥ ९ ॥
दीप्तामन्द्रे द्वितीये च प्रचतुर्थे तथैव च ।
अतिस्वारे तृतीये च क्रुष्टे तु करुणा श्रुतिः ॥ १० ॥
श्रुतयोन्या द्वितीयस्य मृदुमध्यायताः स्मृताः ।
तासामपि तु वक्ष्यामि लक्षणानि पृथक् पृथक् ॥ ११ ॥
आयतात्वं भवेन्नीचे मृदुत्वं तु विपर्यये ।
स्वे स्वरे मध्यमात्वं तु तस्मीक्ष्ण प्रयोजयेत् ॥ १२ ॥
द्वितीये विरता या तु क्रुष्टश्च परतो भवेत् ।
दीप्तान्तां [दीप्तां तां] तु विजानीयात्प्रथमे न (?) मृदुः स्मृताः [°ता?]: ॥ १३ ॥
अत्रैव विरता या तु चतुर्थेन [चतुर्थे न?] प्रवर्तते ।
तथा मन्द्रे भवेद्दीप्ता साम्नश्चैव समापने ॥ १४ ॥
नाविरते श्रुतिं कुर्यात्स्वरयोर्नापि चान्तरे ।
न च ह्रस्वे च दीर्घे च न चापि प्लुतसंज्ञिके ॥ १५ ॥

Nâradî-śikshâ I. i.

Lastly, in the *Bh.* we find no mention of the following characteristics, attached by later writers to the various notes:—

(1) Division into (*a*) *udâtta* (*nishâda* and *gândhâra*), (*b*) *anudâtta* (*ṛishabha* and *dhaivata*), and (*c*) *svarita* (*shaḍja*, *madhyama* and *pañchama*). This classification occurs in *Yâjñavalkya-śikshâ* and in metrically defective verses in the *Pâṇinîya-śikshâ*, neither of which are probably very old. It is easy to see that this classification has no merit. There happened to be three kinds of notes, *viz.*, with two, three and four *śrutis* respectively, and there existed the three varieties of accents, and these were joined together.

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of them three *śrutis*, and the *pañchama*, *madhyama* and the *shaḍja* four each. Thus there are altogether 2×2+2×3+3×4=22 *śrutis* in a *grâma*. निदर्शनं स्वासामभिव्याख्यास्यामः । यथा द्वे वीणे तुल्यप्रमाणतन्त्र्युपवादनदण्डमूर्च्छने षड्जग्रामाश्रिते कार्ये । तयोरेकतरस्यां [°तरां] मध्यममामिकीं कृत्वा पञ्चमस्यापकर्षे [°कर्षयेत्] श्रुतिम् । सामेव पञ्चमवशात् षड्जग्रामिकीं कुर्यात् । एवं श्रुतिरपकृष्टा भवति । पुनरपि तद्वदेवापकर्षयेद् यथा गान्धार-निषादवन्तावितरस्यामृषभधैवतौ प्रवेक्ष्यतो द्विश्रुत्यधिकत्वात् । पुनस्तद्वदेवापकर्षाद्धैवतर्षभावितरस्यां पञ्चमषड्जौ, प्रविशतः [वि]श्रुत्यधिकत्वात् । तद्वत्पुनरपकृष्टायां तस्यां पञ्चममध्यमषड्जा इतरस्यां मध्यमगान्धारनिषादवन्तः प्रवेक्ष्यन्ति चतुःश्रुत्यधिकत्वात् । एवमनेन श्रुतिनिदर्शनेन द्वैग्रामिक्यो द्वाविंशतिश्रुतयः प्रत्यवगन्तव्याः । The corrections in brackets are mine. In other places where the quotation differs from the printed edition I have the authority of one or more Mss. The first correction is justified by the reading of G. तयोरन्यतर मध्यमनामिकिं कुर्यात् । The third correction is self-evident.

[51] S. R. pp. 33-38, *ślokas* 11-23.

[52] S. R., Calcutta, p. 43.

(2) Classification according to supposed descent from various families, *viz.*, (*a*) from the *devas* (*shaḍja, gândhâra* and *madhyama*), (*b*) from the *pitṛis* (*pañchama*), (*c*) from the *ṛishis* (*ṛishabha* and *dhaivata*), (*d*) from the *asuras* (*nishâda*).

(3) Castes—(*a*) *Brâhmaṇas* (*shaḍja, madhyama* and *pañchama*), (*b*) *kshatriyas* (*ṛishabha* and *dhaivata*), (*c*) *vaiśyas* (*nishâda* and *gândhâra*), (*d*) *śûdras* (*antara* and *kâkalî*). Here again it is easy to see that the position of a note in the caste system depends upon its richness in *śrutis*. *Antara* and *kâkalî* (explained in another part of this essay) being only intercalary notes are classed lowest.

(4) Colours.—The colours of the seven notes, as mentioned by Râjâ S. M. Tagore[53] 'according to Sanskrit Authorities,' differ from those given in the S. R. which are respectively as follows:—(1) lotus red, (2) *piñjara* (pale yellow—Simhabhûpâla), (3) golden, (4) *kunda* white, (5) black, (6) yellow, (7) variegated. Certain authors look upon these as examples of 'photisms.'[54] If so the Hindus must be regarded as having not only their sense of vision thus affected by various musical notes, but also their senses of family descent, of caste, of birth-place, of god-fathers (ṛishis), of presiding deities, and of metre! For, they attach all these characters to the musical notes.

(5) Birth-places. The seven *dvîpas* correspond to an equal number of notes, and hence this idea.

(6) *Ṛishis* or god-fathers.

(7) Presiding deities.

(8) Representative Varieties of Metre.

For all these the reader should consult the *S. R.*

(*To be continued.*)

KUMARAPALA AND ARNORAJA.

BY HAR BILAS SARDA, B.A., F.R.S.L., M.R.A.S.; AJMER.

THE Gujarât Chroniclers mention only one war between Kumârapâla, the successor of Siddharâja-Jayasiṁha, king of Anhilwâṛâ and Arṇorâja, king of Sapâdalaksha, as the kingdom of Ajmer was then called. Recent research, however, shows that two distinct wars, separated from one another by several years, took place between the two combatants and that the incidents of the war mentioned by the Gujarât writers belong some to the first and some to the second war.

The *Prabandha-chintâmaṇî* of Merutuṅga and the *Dvyâśraya-mahâkâvya* of Hemachandra place the war they describe at the beginning of Kumârapâla's reign. The *Prabandha-chintâmaṇi* says that prince Bâhaḍa, son of Udayana, who had been adopted by Siddharâja-Jayasiṁha as his son, despising Kumârapâla, made himself a soldier of the king of the Sapâdalaksha country. He, desiring to make war on Kumârapâla, having won over to his side all the officers in those parts with bribes, attentions and gifts, bringing with him the king of the Sapâdalaksha country, surrounded with a large army, arrived on the borders of Gujarât.[1]

The *Dvyâśarya* of Hemachandra says that the Râjâ of Sapâdalaksha, whose name was Anna, when he heard of the death of Jayasiṁha, though he had been a servant of that monarch, now thought the time was come for making himself known. . . . . Anna began to make friends with Ballâla the king of Ujjain and the Râjâs of the country on the west of Gujarât, holding out threats to them as well as promises. Kumârapâla's spies made known to him that Anna Râjâ was advancing upon the western frontier of Gujarât with an army.[2]

[53] *The Musical Scales of the Hindus*, p. 100; *Universal History of Music, addenda* p. vi.

[54] J. Combarieu—*Music, Its Laws and Evolution.*

[1] *Prabandha-Chintâmaṇi* by Tawny, p. 121.

[2] Forbes' *Râsmâlâ* (p. 142), which gives *Dvyâśraya's* account of the war.

CONTRIBUTION TO THE STUDY OF ANCIENT HINDU MUSIC.

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(*Continued from p. 195.*)

The 'grâmas.'

IN the *Bh.* only two *grâmas* are mentioned, *viz.*, the *shadja* and the *madhyama*.[55] The *gândhâragrâma* came into existence and fell into disuse before Sârṅgadeva, who says that it is described by Nârada (a writer on music) and that it prevails in heaven and not on this earth.[56] This *grâma* is mentioned in the *Pañchatantra* in the well-known verse सप्त स्वरास्त्रयो ग्रामा मूर्छनास्त्वेकविंशतिः । This work was translated into Pahlavi in the reign of the Persian king Chosru Nushirvan (A. D. 531-579). If the verse belonged to the original work and was not introduced at the time of a later recasting, the *gândhâragrâma* must be considered as having received recognition before the sixth century A. D. It may also be pointed out that the above verse quoted from the *Pañchatantra* occurs in the *Nâradî-Sikshâ* I. ii. 4, which, though it be not the original work of Nârada mentioned by Sârṅgadeva, is evidently based upon it.

Though the *Bh.* does not define a *grâma*, it plainly indicates that the seven notes in particular relations constitute a *grâma*. The octave being divided into 22 equal intervals, called *śrutis*, the relations of the different notes in the two *grâmas* is as follows:

Shadjagrâma —	*sa*	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	[*sa*]
	3ś	2ś	4ś	4ś	3ś	2ś	4ś	
Madhyamagrâma —	*sa*	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	[*sa*]
	3ś	2ś	4ś	3ś	4ś	2ś	4ś	
Or more accurately,	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	[*ma*]
	3ś	4ś	2ś	4ś	3ś	2ś	4ś	

For, as the type of the *shadjagrâma* begins with *sa*, so the type of the *madhyamagrâma* begins with *ma*. This is evident both from the order in which the different notes in the two *grâmas* are mentioned,[57] and also from the 'first' *mûrchhanâ* in each. The *Saṅgîta-pârijâta* also says that *ma* is the note produced by the open string in the *madhyamagrâma*,[58] though the evidence of this work in matters not personally known to the author is usually of but little value and ought not to be accepted in the absence of corroboration from other sources.

The following are the values of the notes in cents in the two *grâmas*:

Shadjagrâma —	*sa*	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	*sa*
Cents	0	164	273	491	709	873	982	1200
Madhyamagrâma —	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	*ma*
Cents	0	164	382	491	709	873	982	1200

Before we proceed to discuss these scales further, it is absolutely necessary to know which of these notes was taken as the keynote. All modern writers on ancient Hindu music have committed the error of supposing the *shadja* to have been the keynote of the scale, being misled by the present day

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[55] *Bh.* p. 422, *śloka* 110, is likely to make the reader think that in this one place at least the *gândhâragrâma* is referred to; but the word *gândhâre* in that verse is a misreading, as is shown by a comparison with other manuscripts. G. reads कारवीचैव कर्तव्या साधारण समाश्रयाः, which is evidently a mistake for कामरवीच कर्तव्या साधारणसमाश्रया; A. reads कर्मारवीच कर्तव्या साधारितवशाश्रया ।

[56] *S. R.* p. 43, *śloka* 5.

[57] *Bh.* p. 304, *ślokas* 28-29. It may be noted, however, that these *ślokas* occur only in the Ms. G., and not in A., which, as a rule, is more reliable, nor in the Deccan College Mss.

[58] *S. P.* p. 9, *śloka* 101.

usage. But it is easy to see that no note but the *madhyama* could have been the keynote in the days of the *Bh.* For, if we examine the hexatonic and pentatonic *jâtis* or modes, we shall find that they are produced by the omission of one or two notes respectively from the complete scale; and all notes are in turn thus omitted *except the madhyama.* "The omission of all notes [in turn] is allowed in the *jâtis* (modes), but the *madhyama* should never be omitted. For, in the ordinance of music and also in the *sâmans* the *madhyama* is said to be the chief of all notes and non-omissible."[59] But it is just possible that this may only be a repetition of an old rule which had really fallen into desuetude for we meet with such instances in Sanskrit works on music, as will be seen hereafter. We may also consider it possible that though the *madhyama* might have been the keynote in the *madhyama-grâma*, the *shaḍja* might have been the keynote of the *shaḍjagrâma.* But on a careful examination of the *jâtis* we find that even in the *shaḍjagrâma* the *shaḍja* is at times omitted to obtain the hexatonic and pentatonic varieties. It is thus certain that the *madhyama*, which is in no case omitted, must have been the keynote of both *grâmas*, exactly as at the present time the *shaḍja*, which is omitted from none of the *râgas*, is the keynote of the scale in use. This fact of primary importance being once grasped, we can proceed to discuss the two *grâmas* in succession.

For the sake of comparison with modern scales, which are made to begin with the keynote, let the *shaḍjagrâma* be re-arranged with its keynote, the *madhyama*, as the lowest, and we have the *shaḍjagrâma* commencing with its keynote.

Table I.

	ma	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	*ma*
Cents	0	218	382	491	709	873	982	1200

It becomes immediately evident that this scale is practically the same as

	c	d	e_1	f	g	a_1	$b\flat$	c'
Ratios	0	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{16}{9}$	2
Cents	0	204	386	498	702	884	996	1200

which is the European major mode with the exception of the leading note b_1, instead of which we have $b\flat$.[60] The differences between the corresponding notes are 14, 4, 7, 7, 11, and 14 cents, the greatest being 14 cents or two-thirds of a comma, affecting the second note, which is sharper by this amount in the classical Hindu scale. But the fifth is sharp only by 7 cents or one-third of a comma, the fourth is flat by the same amount, and the major third is flat by 4 cents or one-fifth of a comma nearly. Criticising this scale Mr. Bosanquet says[61]:—'The system of 22 possesses, then, remarkable properties; it has both fifths and thirds considerably better than any other cyclical system having so low a number of notes. The only objection, as far as the concords go, to its practical employment for our own purposes, lies in the fifths; these lie just beyond the limit of what is tolerable in the case of instruments with continuous tones. (The mean tone system is regarded as the extreme limit; this has fifths ¼ of a comma flat). For the purposes of the Hindus where no stress is laid on the harmony, the system is already so perfect that improvement could hardly be expected.' He then proceeds to point out the deviations of other intervals, some of which, as noticed above, are large. But it is incorrect to look upon the 22-*śrutis* system as exactly representing the Hindu scale. The European scale is described as consisting of twelve

[59] *Bh.* p. 310, *ślokas* 72-73. सर्वस्वराणां नाशस्तु विहितस्त्वथ जातिषु। न मध्यमस्य नाशस्तु कर्तव्यो हि कदाचन॥७२॥ सर्वस्वराणां प्रवरो ह्यनाशी चैव मध्यमः। गान्धर्वकल्पेऽभिहितः सामस्वपिच मध्यमः॥ ७३॥ The last half *śloka* is the reading of the Deccan College Ms.

[60] For the notation used *Vide Helmholtz's Sensations of Tone*, Engl. Transl., 2nd edn.

[61] *On the Hindu division of the Octave* (Proc. of the R. S. of London), reprinted in Rájá S. M. Tagore's *Hindu Music from Various Authors*, 2nd edition.

semitones to the octave, with the intervals of 2, 2, 1, 2, 2, 2, 1 semitones between its successive notes. A scale constructed according to these data would be

	c	*d*	*e*	*f*	*g*	*a*	*b*	*c'*
Cents	0	200	400	500	700	900	1100	1200

Here the fourths and fifths are more accurate than those in the 22-*śrutis* scale, but all other intervals show the same or greater deviations than are found in that scale.[62] But on that account we do not say that in the European scale the major thirds are wrong by $\frac{2}{3}$-comma, etc. The only legitimate remark that can be made would be that the *expression* of the European scale in terms of twelve semitones as given above, is not an accurate one. Similarly, it is quite as probable that the *expression* of the Hindu scale in terms of 22-*śrutis* is only an approximation.[63] The question then arises—"Do we possess any indications which will enable us to make an accurate determination of the Hindu scale, of which the cycle of 22 *śrutis* might simply be an approximate expression?" To which the reply is, "Yes, for some notes at least."

In the *Bh.* we are told what notes are consonant or *saṁvādins*. 'Two notes with an interval of nine or thirteen *śrutis* between them are consonant with each other. Thus, in the *shaḍja-grâma*, (1) *shaḍja* and *pañchama*, (2) *ṛishabha* and *dhaivata*, (3) *gândhâra* and *nisháda*, (4) *shaḍja* and *madhyama*. So also in the *madhyamagrâma* with the exception of *shaḍja* and *pañchama*. Here [in the *madhyamagrâma*] there is consonance of *pañchama* and *ṛishabha*.'[64] This at once enables us to write the exact values of all the notes except two, since it is evident that the interval of nine *śrutis* represents the just Fourth, and that of thirteen the just Fifth Thus we have

		4ś	3ś	2ś	4ś	3ś	2ś	4ś
A	Notes	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	*ma*
	Ratios	1	$\frac{9}{8}$		$\frac{4}{3}$	$\frac{3}{2}$		$\frac{16}{9}$	2
	Cents	0	204		498	702		996	1200

Only two notes remain, *viz.*, *dha* and *ri*. They are mutually consonant, but neither of them being consonant with a note of known value their own values cannot be determined by this method. But before considering any suggestions as to their probable values, it is necessary to note the difference between the exact values thus obtained of the various intervals, and those calculated from the cycle of 22, which was brought into existence in order to express them.

Intervals.	Exact value in cents.	Defective expression of the value by the cycle of 22.
Major tone of 4 *śrutis* ...	204	218
Minor Third of 5 *śrutis*...	294	273
Just Fourth of 9 *śrutis* ...	498	491
Just Fifth of 13 *śrutis* ...	702	709

[62] This is the well-known equal temperament scale of Europe, and though in extensive use, is not the ideal just scale.

[63] Indeed, this ought to be evident *a priori*. Thus, for instance, a note and its fifth or a note and its octave are the actualities presented to us first, and afterwards comes the idea of measuring and comparing them. Now, it is easy to see that we may be in possession of two definite magnitudes, but for various reasons may not be able to express one exactly in terms of the other. The intervals of an octave and a fifth are examples in point. Hence the various cycles proposed, such as those of 12 and 22. It would be putting the cart before the horse to treat the semitone or the *śruti* as the primary notion and to seek to establish the fifth of a note by going up 7 semitones or 13 *śrutis*.

[64] *Bh.* p. 303. The *S. R.* means the same thing when it says 'that those notes, in the interval between which there are twelve or eight *śrutis*, are consonant with each other.' But this mode of expression is objectionable for the same reason that it is objectionable to say that between the 1st and 14th of January intervene twelve days, and between the 1st and the 10th eight.

The interval of 8 *śrutis* is of no value for our present purpose, being simply composed of two intervals of 4 *śrutis*. Similarly other available intervals being only defects of these intervals from the octave of 22 *śrutis*, need no separate consideration. From the above table it will be seen that the system of 22 *śrutis* is capable of introducing an error of as many as 21 cents or nearly a comma in an attempt to *express* by means of it an interval, the value of which is known beyond all doubt by the method of consonances. We can now proceed to discuss some values for the undetermined notes, which offer themselves for consideration, remembering that a deviation to the extent of about a comma need not by itself stamp them as improbable:—

(1) The first value we shall consider will be that suggested by Mr. Hipkins, who holds that the 3-*śrutis* interval must be taken as a $\frac{3}{4}$-tone. We have seen that on the 22-*śrutis* scale the calculated value of the 4-*śrutis* interval is 218 cents but that the real value was 204 cents. A $\frac{3}{4}$ tone, therefore, must be equal to 153 cents, an interval known to be used in the East. But the substitution of this value leaves 141 cents as the value of the 2-*śrutis* interval between *dha* and *ni*, or between *ri* and *ga*, and it is impossible to believe that the two intervals of 153 and 141 cents, differing from each other only by 12 cents, should have been expressed by 3 and 2 *śrutis* respectively. We cannot, therefore, look upon the 3-*śrutis* interval as a $\frac{3}{4}$-tone. The same fact may be put in another light. The two intervals of 153 and 141 cents are so nearly equal that each of them may be looked upon as equal to 3-*śrutis*, and it will be found that the whole scale can then be more accurately expressed by means of the cycle of 24 than by means of one of 22, thus:

Notes	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	*ma*	
The scale to be expressed ...	0	204	357	498	702	855	996	1200	cents
Values expressed by means of cycle of 22 *śrutis* ...	4*ś* 0	3*ś* 218	2*ś* 382	4*ś* 491	3*ś* 709	2*ś* 873	4*ś* 982	1200	cents
Values expressed by means of cycle of 24 *śrutis* ..	4*ś* 0	3*ś* 200	3*ś* 350	4*ś* 500	3*ś* 700	3*ś* 850	4*ś* 1000	1200	cents

A glance at this table shows the greater accuracy of expression obtainable by means of 24-*śrutis* scale, if the 3-*śrutis* interval were intended to be a $\frac{3}{4}$-tone as Mr. Hipkins supposes. But since the Hindus fixed upon 22-*śrutis* only, it is evident that they did not intend the 3-*śrutis* interval to be a $\frac{3}{4}$-tone.

(2) Secondly, we shall consider the value of the 3-*śrutis* interval calculated on the basis of 22-*śrutis* to the octave, which is 164 cents. In the first place let it be noted that if this value has a claim on our consideration, that claim is shared to an equal extent by the value assignable to *dha* by a calculation on the same basis, *viz.*, that of 7-*śrutis* = 382 cents, and this we shall proceed to do in the next paragraph. In the meanwhile if we take 164 cents as the value of the 3-*śrutis* interval, the value of the neighbouring 2-*śrutis* interval becomes 130 cents, and the same objection presents itself as before, *viz.*, the improbability of taking the two intervals of 164 cents and 130 cents for a 3-*śrutis* and a 2-*śrutis* interval respectively.

(3) Lastly, let us consider the value of *dha* obtained by calculating on the same basis as in the last paragraph, which is 382 cents. This gives very remarkable results. The 3-*śrutis* and 2-*śrutis* intervals have now the values of 178 cents and 116 cents respectively, which are almost exactly in the ratio of 3 : 2. An additional argument for accepting this value is the consideration that the Hindus in choosing the cycle of 22 were more likely to have aimed at securing a greater accuracy in the expression of the relations of the fourth, the fifth and the thirds than that of smaller intervals like the seconds. It will be noticed that this value of the major Third, *viz.*, 382 cents, differs only by 4 cents from the value of the just major Third which is 386 cents, and there is nothing against the supposition that probably this was the actual value of that interval; the

small difference being due to the unavoidable defect of the system of 22-*śrutis*, selected for expressing the relations of the notes in the scale. This defect is shared by all systems, and it can be diminished only by admitting a greater number of degrees.

Finally an express statement in the *S. P.*[65] gives a death-blow to the ¾-tone notion, and indirectly supports the value which we must assign to the 3-*śrutis* interval as a consequence of the value we have found for the 7-*śrutis* interval. With 386 cents for the latter, we have 182 cents (a minor tone) for the former, whereas the ¾-tone is only about 150 cents. From the data given in the *S. P.* for the division of a string the ratio of the 3-*śrutis* interval between *sa* and *ri* is $\frac{9}{8}$ or 204 cents (a major tone), and of that between *pa* and *dha* is $\frac{8}{7}$ or 231 cents. Even allowing for the errors inevitable in determinations of the values of notes by the division of a string in a fretted instrument like the Hindu *bîn*, it is evident that a minor tone may be confounded with a major tone, but it is not easy to believe that a ¾-tone can thus be confounded. On the other hand it would be quite legitimate to bring forward the objection that originally the 3-*śrutis* interval might have had a different value from that which it came to have in the days of the *S. P.*; but there is no evidence to support this hypothesis.

Inserting the value we have found for the 7-*śrutis* interval in the Table A, we have the complete scale as follows:

B		4ś	3ś	2ś	4ś	3ś	2ś	4ś	
		ma	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	*ma*
	Ratios	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{16}{9}$	2
	Cents	0	204	386	498	702	884	996	1200

From what has been said above it will be evident that the values of all notes given in this table are perfectly certain, except those of *dha* and *ri* which may be looked upon as *almost* certain.

It is now necessary to notice the following remarks of Mr. A. J. Hipkins: "The Indian scale intervals ought to be understood as they are explained by native writers—namely, as a tone, a ¾-tone, and a ½-tone, composed of 4, 3, and 2 *śrutis* respectively. With this conception of intervals, and it must be borne in mind the ¾-tone is still approved of in the East, a division of the octave into 24 equal quarter-tones becomes impossible. For as it was essential to secure an approximately perfect fourth with 9 *śrutis*, and a fifth with 13, the division of the octave by 22 was the only one available. The error in the fourth of 9 equal *śrutis* of a 22 division is no more than ⅓-comma, in melody scarcely noticeable, but the error in a 21 or in a 23 division could not have been easily tolerated."[66] At the outset, in this connection let me ask the reader to recall what I have said above, about the system of 22 *śrutis* being called into requisition to *express* the relations of the notes in an already existing scale and the inherent inability of all systems to *express accurately* the so-called natural scale unless the octave is subdivided into a very large number of degrees. But this is not all. Mr. Hipkins is actually in error when he supposes that Hindu writers explain the intervals of their scale as being 'a tone, a ¾-tone, and a ½-tone.' Hindu writers have never said this; they only say that there are three sorts of intervals, consisting of 4, 3 and 2 *śrutis* respectively—in other words in the ratio 4 : 3 : 2. This is very different from what is understood by European writers by 'a tone, a ¾-tone, and a ½-tone.' Consider the intervals 200, 150, and 100 cents. European writers will call them a tone, a ¾-tone, and a ½-tone respectively, which is correct. But now take the well-known intervals 204, 182, and 112 cents, or a major tone, a minor tone, and a diatonic semitone. These they will forthwith describe as a tone, a tone,

[65] See below.

[66] Capt. Day's *The Music of Southern India*, pp. 20-21.

and a semitone respectively, which is only an approximation and not accurate, for, the exact ratios are 1·8214 . . . : 1·625 : 1, and not 2 : 2 : 1. The approximation may be justified thus : 1·8214 . . . is nearly 2; and 1·8214 : 1·625 = 1·1225 : 1, *i. e.*, 1 : 1 nearly. But there is another way also of looking at these ratios : 1·8214 : 1 = 2 : 1 approximately, as before; but 1·625 : 1 = 1·5 : 1, more nearly than 2 : 1 ; in other words, the three intervals are in the ratio 4 : 3 : 2 approximately. It is this approximation which has been used by Sanskrit writers. It will be seen that the two approximations agree as regards the ratio between a major tone and a semitone ; and if the European approximation is more accurate as regards the ratio of a major to a minor tone, the Hindu approximation has the advantage of greater accuracy in the ratio of a minor tone to a semitone. The latter possesses the further advantage of indiciting that there are three kinds of intervals, whereas the former reduces these to only two. It was probably owing to this European custom of calling the major tone, the minor tone, and the diatonic semitone by the terms a tone, a tone, and a semitone that Mr. Hipkins overlooked the possibility of the Hindu approximation being quite as good, if not better, for the purpose of expressing the actual ratios, and was led to misinterpret the intervals of the Hindu scale.

Having thus determined the values of the intervals in the Hindu scale, it will be interesting to consider now the converse problem of what cycles can possibly be employed to express the same. The conditions of the problem evidently are:

(1) There must be three kinds of intervals.

(2) The octave to consist of three intervals of the greatest magnitude and two of each of the others.

(3) Integers only to be used in expressing the intervals.

It is easily seen that no cycle of less than 15 degrees can satisfy all these conditions. The cycle of 53 with the three intervals in the ratio of 9 : 8 : 5 can express the scale with remarkable accuracy. If we now examine all possible cycles consisting of 15 to 53 degrees, which satisfy these conditions, only the following ones make an approach to the scale for which we wish to find an expression :

Table C.

Degrees in the cycle.	Ratios of the three intervals.	Degrees in the Major Third.	Cents in the Major Third.	Degrees in the Fifth.	Cents in the Fifth.
22	4 : 3 : 2	7	382	13	709
29	5 : 4 : 3	9	372	17	704
32	6 : 4 : 3	10	375	19	712·5
34	6 : 5 : 3	11	388	20	706
41	7 : 6 : 4	13	380·5	24	702
46	8 : 7 : 4	15	391	27	704
53	9 : 8 : 5	17	385	31	702
Scale under consideration	1·8214 . : 1·625 : 1	...	386	...	702

Thus the cycle of 22 is the smallest that can be used for expressing the given scale ; that of 29 gives the fifth more accurately, but the third is much worse ; that of 32 is decidedly worse ; the rest are all better, that of 53 being the best. We thus see that *assuming* the value of the scale, which we have found from other consideration, to be correct, it could not have been better expressed than by means of a cycle of 22, unless the ancient Hindu writers had resorted to 34 degrees or more. This consideration, therefore, gives further indirect support to the value we have assigned to the scale. Why cycles of 34 degrees or more were not used so as to secure a greater accuracy will be discussed presently ; but we must first consider an apparently formidable objection. In the section "On the *svaras* and *śrutis*" it has been mentioned that, according to Bharata, in order to convert the *shaḍjagrâma* into the *madhyamagrâma*, the *pañchama* must be lowered

by a *śruti* so as to make it consonant with the *ṛishabha*. But according to the values which we have come to assign to the different notes (see Table B), the necessary lowering amounts to only a comma or 22 cents, which is less than even half of the average value of a *śruti*, which is $54\frac{6}{11}$ cents. It is not this discrepancy, however, which is the difficulty in our way, as it is really of no importance. For, it is easy to see (and the reader may convince himself of it by actual trial) that it must necessarily occur in *all* cycles, whenever it is sought in this manner to find the value of one *particular* degree, unless indeed the cycle chosen is such that the difference between the major and the minor tone is represented by one degree, and that the value of each degree is as nearly as possible 22 cents, consistently with its giving good values for other intervals. Such a cycle is that of 53 in the Table C above. Why this cycle was not adopted by the Hindus to express their scale, if the latter was really the same as that I have arrived at from other considerations, will be discussed further on. It is sufficient for my present purpose to make the reader understand that the fact of the difference between the major and minor tones being only 22 cents (*i. e.*, very much less than the average value of a *śruti*) in no way goes against the value we have come to assign to the Hindu scale. Indeed, we can even go further and say that whoever might have originated the cycle of 22 to represent the Hindu scale, Bharata and Matanga were misled into straining it in an unjustifiable way, when they said that the amount of flattening necessary to make the *pañchama* of the *shaḍjagrâma* consonant with the *ṛishabha* was the measure of a *śruti*. It will be seen that this error is quite natural, since with the adoption of the cycle of 22 we are forced to represent the major tone by 4 and the minor tone with 3, and the just Fourth and Fifth with 9 and 13 respectively. Now in the *shaḍjagrâma* the *pañchama* is not consonant with the *ṛishabha* and the interval between the two is expressed by 10 or 12 according to the direction in which you measure. In order to make it consonant (as in the *madhyamagrâma*), it must be flattened by a certain amount; but no sooner this is done the interval must be expressed by 9 or 13 (according to the direction in which you measure), since those are the numbers by which we must denote the intervals of consonance in the cycle of 22. In other words, you are obliged to *say* that the *pañchama* has been flattened by one unit, however much the necessary amount of flattening may actually differ from the average value of that unit. This apparently correct but really erroneous statement then can in no way go against the value we have come to assign to the Classical Hindu Scale. But the same cannot be said of the experiment described in the *Bh.* in connection with the exposition of the *śrutis* (see the section "On the *svaras* and *śrutis*" above). In this experiment, it will be remembered, we have, at starting, two *vîṇâs* in unison tuned to the *shaḍjagrâma*. The tuning of one of them is subsequently changed to the *madhyamagrâma* by lowering the *pañchama* by the requisite amount, which with our present values for the notes of the scale will only be a comma or 22 cents. The remaining strings are now lowered so as to have the *shaḍjagrâma* tuning once more. Supposing this can be accurately done, every string of this *vîṇâ* ought to give a note lower by a comma than the note of the corresponding string of the other. Performing this double operation once more, the difference in notes of corresponding strings will be two commas or 44 cents only, and the *gândhâra* and *nishâda* strings of the changing *vîṇâ* cannot possibly give notes in unison with the *ṛishabha* and *dhaivata* of the other. But Bharata says that they do; and there will be the same discrepancy in the rest of the experiment. Now if we believe that this experiment was actually performed by some musician with the stated result, we are forced to give up the values we have assigned to the notes in the Hindu scale and to admit those found by actual calculation on the supposition that the 22-*śrutis* cycle represented the scale *exactly* (see Table I). But this necessarily leads to the consequence that we must admit that the Hindu year was so peculiar that when it declared two notes to be consonant they were not so according to our present notions, but that the just Fourth was

consistently flatter by 7 cents and the just Fifth as *consistently* sharper by the same amount. When we further note that the values of the Fourth and the Fifth as given in the *S. P.* are exact, we must make the additional admission that this peculiarity of the Hindu ear had disappeared by the time that that work was written. I think this to be beyond belief, and consider that when the Hindu musicians declared that there was consonance between two notes it was exact consonance as given in the *S. P.* and as understood at present. The necessary result of this view is that we must look upon the experiment in question as only a paper or imaginary experiment, based on the excusable error pointed out above, *viz.*, that the amount of flattening necessary to make the *pañchama* consonant with the *ṛishabha* was taken to be really equal to one *śruti*, whereas it was so only in name, one being forced to call it a *śruti* owing to the exigencies of the cycle adopted, *viz.*, that of 22. In confirmation of the imaginary nature of the experiment I may draw the attention of the reader to the fact that in the *Bh.* we are asked to take two *vîṇâs* tuned to the same *mûrchhanâ* and having strings and *daṇḍa* (the wooden bar proceeding from the body) of the same dimensions. It is easy to see that a real experimenter ought to perceive that it is not essential to have the strings and *daṇḍa* of the same dimensions. Further, since there are only seven strings in the *vîṇâ*, the tuning of which is kept fixed, a real experimenter would have discovered that as he proceeded with the successive lowerings of the strings of the other *vîṇâ*, there would be no strings in the fixed *vîṇâ* with which some of the lowered strings could be in unison. As an illustration, suppose that the two *vîṇâs* were tuned to the first *mûrchhanâ*, *viz.*, *sa*, *ri*, *ga*, *ma*, *pa*, *dha* *ni*, and the procedure of lowering the second *vîṇâ* by a *śruti* was repeated four times, then the *ma* and *pa* strings of this *vîṇâ* would be in unison with the *ga* and *ma* strings of the fixed *vîṇâ*; but the *sa* string of the second *vîṇâ* could not be in unison with the *ni* string of the first, as stated in the *Bh.*, the latter being an octave higher. A real experimenter would have certainly noticed this.

Having thus disposed of the only objection of some real importance, we must now try to find out why the Hindu musicians did not employ a cycle like that of 53 so as to be able to give an accurate expression to their scale, if it had the constitution which we have found for it. And the reason is not far to seek, if we keep in mind how the *śruti* interval was determined. Mr. A. J. Hipkins[67] confidently says that 'There can be no doubt about the origin of the *śruti* in the measurement of a stretched string,' but has omitted to give the grounds for his assertion. At first sight this assertion does look plausible. For, if we divide a stretched string into two, and subdivide one of the halves into two again and continue the subdivision in this manner, we shall come in due course to the fraction $\frac{1}{2^7}$; and if the string be damped at this distance from the nut the remaining portion of the string $= \frac{2^7-1}{2^7}$ ought *theoretically* to give a note which is 55 cents higher than that of the whole string; and 55 cents is almost exactly one *śruti* ($= 54\frac{6}{11}$ cents). But if the experiment be *actually* performed, it would be found that the result is far from accurate. It is improbable, therefore, that the *śruti* interval was arrived at by the measurement of a stretched string. There are other considerations also which go against this notion. In the *Bh.*, which mentions the *śrutis*, there is no reference to the production of higher notes by stopping a string. The Hindu *vîṇâ* in its oldest form had no finger-board which occurs only in more recent forms, and the frets were added at a still later period. Even in the *S.R.*, though fretted instruments were in existence at the time, the 22 *śrutis* are demonstrated not by means of subdivision of a string, but by means of a *śrutivîṇâ* with 22 strings, each having a pitch slightly higher than that

[67] Capt. Day's *The Music of Southern India*, Introduction, p. xi.

of the preceding one so that the fourth gave the *shaḍja* note and the last the *nishâda*.[63] From all this it is clear that the *śruti* interval could not have had its origin in the measurement of a stretched string. But even supposing that the value of the interval was thus fixed by subdividing a string into 32 parts, for obtaining the value of 2 *śrutis* we must take 31 of these parts and divide this again into 32, and so on for larger intervals, with the result that every such successive operation must increase the error, which unavoidably attends the experiment as noticed above. This makes it more probable that the relative values of the different notes in the scale were actually determined by trial by means of the ear with the help of strings rising in pitch step by step, as conceived, for example, by Śârṅgadeva. This I think may also account for the name *śruti* (*something heard*) given to the unit of measurement which resulted from such a process. Now, since equal rises in pitch have to be determined only by the ear, it is easy to see that the greater the number of degrees in a cycle the smaller is the value of each degree, and consequently the more difficult it is for the ear to appreciate the equality of each step in the pitch. We need not wonder then that the Hindus could not resort to a cycle like that of 53 and had to stop at one of 22, which, by the way, as pointed out above, cannot be excelled by another of less than 34 degrees.

To sum up, the values of notes in the Classical Hindu Scale (the *shaḍjagrâma*) are as follows :

		4ś	3ś	2ś	4ś	3ś	2ś	4ś
B	Notes	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*	*ma*
	Ratios	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$	$\frac{5}{3}$	$\frac{16}{9}$	2
	Cents	0	204	386	498	702	884	996	1200

As previously remarked, the values, given in this table, of all notes except *dha* and *ri* are absolutely certain, and I believe the evidence I have given is sufficiently convincing as regards the correctness of the values of the latter two also.

Now, we arranged the *shaḍjagrâma* thus, with its keynote at the commencement, to enable a comparison to be made with the modern European major scale, from which it differs only in the seventh note being flatter by a chromatic semitone + a comma. The correct way, however, of representing it, is this, *viz.*, with *sa* as the lowest note :

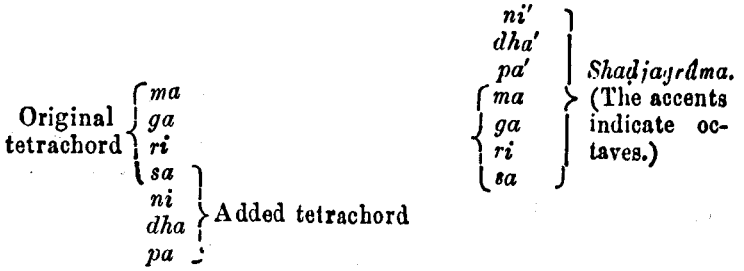
The 'shaḍjagrâma.,

	3ś	2ś	4ś	4ś	3ś	2ś	4ś	
sa	*ri*	*ga*	*ma*	*pa*	*dha*	*ni*	[*sa*]
$\frac{3}{4}$	$\frac{5}{6}$	$\frac{8}{9}$	1	$\frac{9}{8}$	$\frac{5}{4}$	$\frac{4}{3}$	$\frac{3}{2}$

[63] *S. R.* I. iii. 12 *et seq.* The experiment is not as accurately described as one would wish. We are asked to tune the 22 strings each a *little* higher-pitched than the preceding *so that between two successive notes produced by them there should not exist an intermediate note.* These directions are evidently defective, for we *can* have notes of intermediate pitch. Then again, it would have been better to have 23 *strings* with 2 *intervals*, so that at the fourth lowering of the strings it would have been possible to show that the *sa* string of the changeable *vîṇâ* was in unison with the *ni* string of the fixed *vîṇâ*. A similar inaccuracy of expression of the author I have noticed above. But the experiment was probably not quite imaginary like that in the *Bh.*, referred to above. At any rate we are not asked to have the strings and *daṇḍa* of the same dimensions but are only required to construct two similar *vîṇâs*, the similarity consisting in their producing identical sounds—द्वे वीणे सदृशौ कार्ये यथा नादः समो भवेत्. I think Siṁhabhûpâla's explanation of this verse is correct, and Kallinâtha's is not. The latter says सदृशौ सदृशाकारे ; the former सदृशौ समाने । आकारसाम्यं नात्रोपयुज्यत इत्याह 'यथा नादः समो भवेत्' यथा नादः समान एव भवतीति । Indeed one might almost think that the author had before him the expression तुल्यप्रमाणतन्त्र्युपवादनदण्डमूर्छने of the *Bh.* and wrote यथा नादः समो भवेत् as a correction. In passing, it may be noted that this experiment does not go against the values we have come to assign to the Classical Hindu Scale, remembering that the intervals are to be judged by the ear.

This arrangement at once makes clear why the *ga* of the Classical Hindu Scale differs from, the *ga* of the modern Hindu scale. In the former, the first tetrachord is really a descending one, whereas in the latter it is ascending. It will be noticed presently that in the *Bh.* we are told that if the note *antara ga* (which corresponds to modern *ga*) is to be used, we can do so only in going up the scale.

It will be noticed that the arrangement of the *shadjagrâma* as given above is such as to tempt one to think that it consisted of two disjunct tetrachords; and this is indeed the way in which it came to be looked upon by later writers. But at the time we are speaking of, the octave was not recognised and the *grâmas* consisted only of seven notes.[69] This leads to the conjecture that the original descending tetrachord *ma, ga, ri, sa* was, in the first instance, extended not upwards as *pa, dha, ni, sa*, but downwards as a conjunct tetrachord *sa, ni, dha, pa*, the common note being *sa*; the three new notes *pa, dha, ni* were subsequently transferred (as octaves) above the keynote *ma*, thus producing the heptachord *shadjagrâma*. Some further support is given to this view by the quotation from the *Nâradî-Śikshâ* given above (*ante*, Vol. XLI, p. 162). Indeed the matter would have been beyond all doubt, if in that quotation the *nishâda* had been spoken of as the fifth note and the *dhaivata* as the sixth.



The *madhyamagrâma* seems to have been a later development in the evolution of Hindu music; for, in defining it, the *Bh.* tells us how the *shadjagrâma* must be modified in order to arrive at the former, *viz.*, by flattening the *pañchama* by one *śruti*. In this *grâma* the keynote *ma* was placed at the commencement (see above). We have, therefore,

The 'madhyamagrâma.'

	3ś	4ś	2ś	4ś	3ś	2ś	4ś	
ma	*pa*	*dha*	*ni*	*sa*	*ri*	*ga*		[*ma*]
1	10/9	5/4	4/3	3/2	5/3	16/9		2

The reader will at once notice that this *grâma* is the same as the Seventh of what are known as Ecclesiastical Modes, whereas the *shadjagrâma* is the Eighth and related to it as a plagal to an authentic one. In India, therefore, it would appear that the plagal mode preceded the authentic one in order of time (*Sâman* chants, of which we know but little, being kept out of consideration). The contrary, it is stated, was the case in Europe.

Other Notes in the Bhâratîya-nâṭya-śâstra.

Besides the seven notes discussed above, the *Bh.* recognises four more, under the name *svara-sâdhâraṇam* ('common note'), which is explained to be an '*antara-svara*' ('an intercalary note'). These are (1) *kâkalî-nishâda*, (2) *antara-gândhâra*, (3) *shadja-sâdhâraṇa*, and (4) *madhyama-sâdhâraṇa*.

The values of *kâkalî-nishâda* and *antara-gândhâra* can be easily fixed from the datum in the *Bh.*, *viz.*, that they are two *śrutis* sharper than *nishâda* and *gândhâra* respectively. The former note makes the intervals between *dha* and *kâkalî ni*, and between *kâkalî ni* and *sa* a major

[69] It is for this reason that I have placed the 8th note in brackets.

tone and a diatonic semitone respectively; similarly, the latter makes the interval between *ri* and *antara ga* a major tone, and that between *antara ga* and *ma* a diatonic semitone. These notes, however, were used with great restrictions: (1) They were to be used *only* in going up the scale, and even then in a passing manner without dwelling on them; (2) they were to be used only in the three *jâtis—madhyamâ, pañchamî*, and *shaḍja-madhyâ*—and even then only if the *aṃśa-svara* was *sa, ma* or *pa* in the first and third, and *pa* in the second.

The *shaḍja-sâdhâraṇa* and *madhyama-sâdhâraṇa* were notes intermediate between *nishâda* and *shaḍja*, and between *gândhâra* and *madhyama*, respectively; and the difference between them and the corresponding natural notes was so minute that they were designated also by the name *kaiśika* ('hair-like'). Further, the *shaḍja-sâdhâraṇa* could be employed only in the *shaḍjagrâma*, and the *madhyama-sâdhâraṇa* in the *madhyamagrâma*. We have no data in the *Bh.* to enable us to determine the values of these. From the *S. R.*, however, we see[70] that according to later writers they were produced by the following relations of notes:

Shaḍja-sâdhâraṇa *dha* *ni* *sa* *ri*
3ś 2ś 4ś

Madhyama-sâdhâraṇa *ri* *ga* *ma* *pa*
3ś 2ś 4ś

Further, it would seem that though, as in the *Bh.*, *madhyama-sâdhâraṇa* was confined to the *madhyamagrâma*, there was no corresponding restriction on the *shaḍja-sâdhâraṇa*.

A change had also occurred in the mode of employing *kâkalî-nishâda* and *antara-gândhâra*.[71] Firstly, one could descend thus:

sa kâkalî-ni dha (*c B A*)
ma antara-gândhâra ri (*f e d*)

Secondly, one could follow this procedure:

sa kâkalî-ni sa the next higher note available
ma antara-gândhâra ma the next higher note available

By the words 'the next higher note available' is to be understood, 'the next higher note, making allowance for such notes as are required to be omitted in the particular mode to be played or sung.' It will be observed that though the second procedure may be looked upon as in accordance with the teaching of the *Bh.*, the first goes directly against it. It is impossible for us to find out when and how the change came about, as no works on music in the period between the *Bh.* and the *S. R.* are extant. The author of the *S. R.* himself, it must be noted, is not writing from his own knowledge, but on the authority of the writers who preceded him, and whose works were then available. The ancient music had already passed away in the time of Śârṅgadeva, the author of the *S. R.*

The 'grâmas' according to later writers.

The structure of the two *grâmas* as given in the *S. R.*, which is a compilation made from previous works, is exactly as given in the *Bh.*[72] But in the *S. P.*, which is a work of a much later period (see above) and when the old distinction of the *grâmas* had been completely forgotten,[73] though there is agreement in the structure of the *shaḍjagrâma*, that assigned to the *madhyama-grâma* is as follows with *ma* for keynote:

ma *pa* *dha* *ni* *sa* *ri* *ga* [*ma*]
3ś 3ś 3ś 4ś 3ś 2ś 4ś

[70] *S. R.* p. 64, *ślokas* 7 and 8.
[71] *S. R.* p. 64, *ślokas* 3, 4, 5 and 6.
[72] The reader should note that the arrangement of *śrutis* in the *madhyama* and *gândhâra grâmas*, as drawn up in App. iv of the *S. R.* Anandashrama series, is *not* according to the text. It agrees with that given in the *S. P.*
[73] *S. P. kâṇḍa* i., *śloka* 100.

This must be looked upon either as having its origin in the imagination of the author, an occurrence by no means very rare, or as having been quoted from a previous writer, equally imaginative. According to the *S. R.*,[74] however, this was the constitution of the *gândhâragrâma* of Nârada, which had already fallen into desuetude (see above). For, this authority gives the following arrangement of *śrutis* in this *grâma*.

The 'gàndhâragrâma.'

ga	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	[*ga*]
3	3	3	4	3	2	4	

Here it would seem that *ga* was the keynote, and in that case it is not very difficult to attach a plausible meaning to the scale. For, on comparing it with the *shaḍjagrâma* it will be observed that it is identical with it except for the fact that the interval between the second and the fourth notes, which amounts to $\frac{8}{9}$ or a minor third, is sought to be equally divided. If this conjecture be correct, it reminds us of a similar division introduced by Zalzal (8th century A. D.) in the Arabic scale and said to be still in use.[75] In India, however, it fell into disuse, which probably gave rise to the myth that 'it was prevalent in heaven (*svarga*) and not on the face of the earth.'[76] It is said to have originated with Nârada, a writer on music, but there is no inherent improbability in its having been borrowed by the Hindus from the Persians and Arabs, like so many other things in music (see below).[77]

The *S. P.* having thus given a constitution for the *madhyamagrâma*, which according to the *S. R* belongs to the *gândhâragrâma*, proceeds to define the *gândhâragrâma* as follows with *ga* for the keynote:

ga	*ma*	*pa*	*dha*	*ni*	*sa*	*ri*	[*ga*]
3	3	3	4	3	3	3	

No other Sanskrit treatise on music, available to us, mentions a *grâma* with this structure. If we examine, however, the original *gândhâragrâma* as given in the *S. R.* (which is the same as the *madhyamagrâma* as defined in the *S. P.*), we find that the seventh note is the just Fourth of the fourth note but is not the just Fifth of the third. In the *gândhâragrâma*, according to the *S. P.*, it would appear, the seventh note is made the just Fifth of the third note, sacrificing its relation of the just Fourth to the fourth note, the other relations remaining the same.

(To be continued.)

KALIDASA AND THE HUNAS OF THE OXUS VALLEY.

BY PROF. K. B. PATHAK, B.A.; POONA.

KSHÎRASVÂMÎ, the well-known commentator on the *Amarakośa*, who belongs to the second half of the eleventh century,[1] explains *vâhlîka*,[2] meaning saffron, thus:

वह्लीकदेशजं यद्रघोरुत्तरदिग्विजये
दुधुवुर्वाजिनः स्कन्धाल्लग्नकुङ्कुमकेसरान्।

In order to enable the reader to understand the view of Kshirasvâmî, I shall quote the following three well-known verses of Kâlidâsa:

ततः प्रतस्थे कौबेरीं भास्वानिव रघुर्दिशम्।
शरैरुत्तेरिवोदीच्यानुद्धरिष्यन् रसानिव॥
विनीताध्वश्रमास्तस्य वङ्क्षतीरविचेष्टनैः।
दुधुवुर्वाजिनः स्कन्धाल्लग्नकुङ्कुमकेसरान्॥
तत्र हूणावरोधानां[3] भर्तृषु व्यक्तविक्रमम्।
कपोलपाटनादेशि बभूव रघुचेष्टितम्॥ *Raghuvaṁśa* IV.

[74] *S. R.* p. 46, *ślokas* 3, 4, and 5.
[75] In the 13th, 14th and 15th centuries, however, Zalzal's neutral third was not in favour. (Prof. Land's *Gramme Arabe*).
[76] *S. R.* p. 46, *śloka* 5.
[77] If we are to believe, however, that this *grâma* was in existence in India at the time when the *Pañchatantra* was first translated into Pahlavi (see above), the Hindus could not have borrowed it from the Arabs.
[1] He quotes Bhoja and is quoted by Vardhamâna, the author of the *Ganaratnamahodadhi*.
[2] Mr. K. G. Oka's Ed. of the *Kshîrasvâmî*, p. 110.
[3] Some manuscripts of Vallabha's commentary read हून.

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